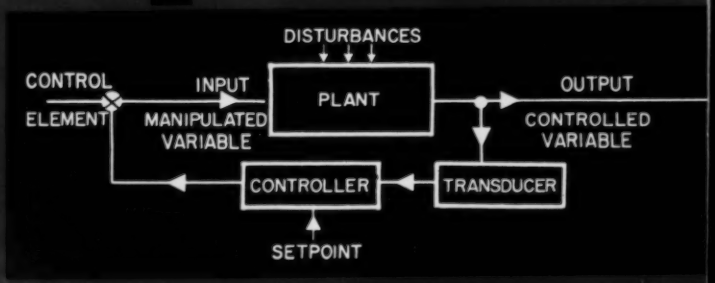
INSTRUMENTS and AUTOMATION

Including:
Instrument Manufacturing
The Journal of the SCMA
Simulation Council Newsletter

b



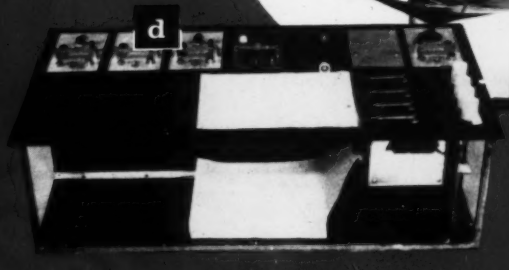
b. Controlling the pure-delay plant 1721

c, d. The old and the new in medical education 1712

e. Multiple-address magnetic-tape transport 1725

c

d



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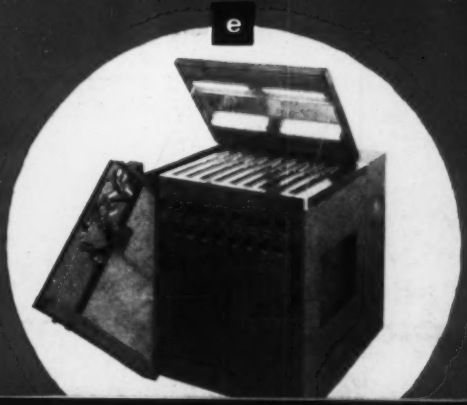
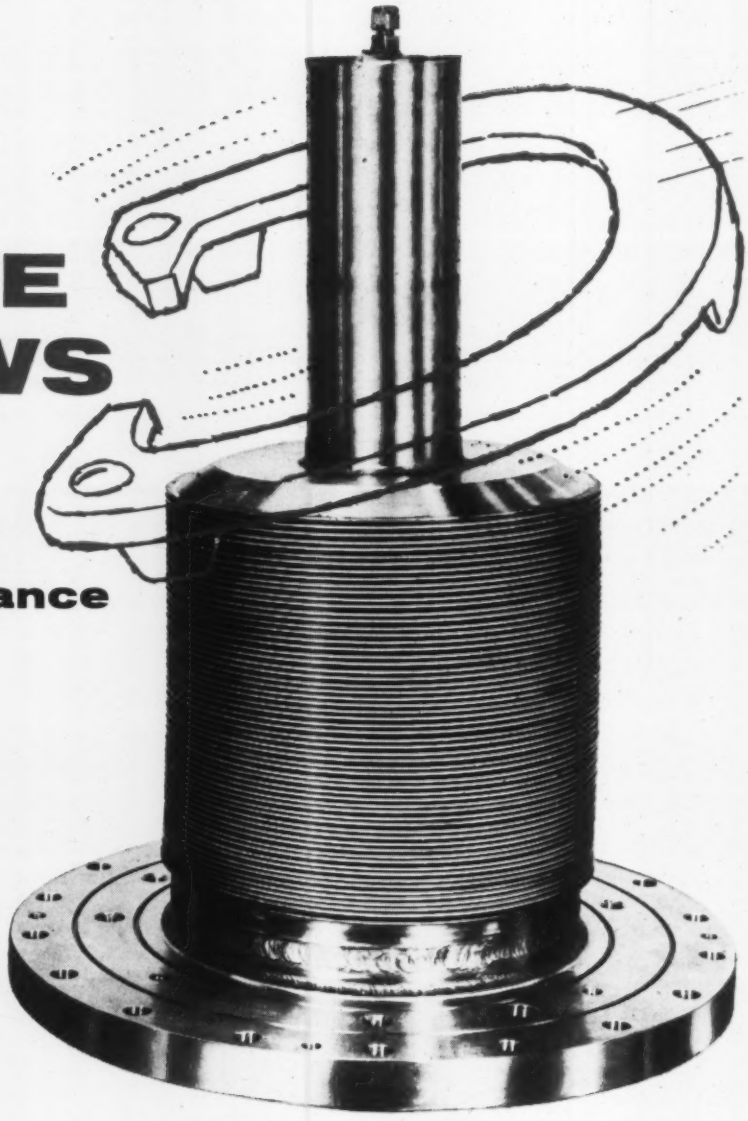


SEPTEMBER 1957

BREEZE BELLOWS WIN

the tough game of high performance



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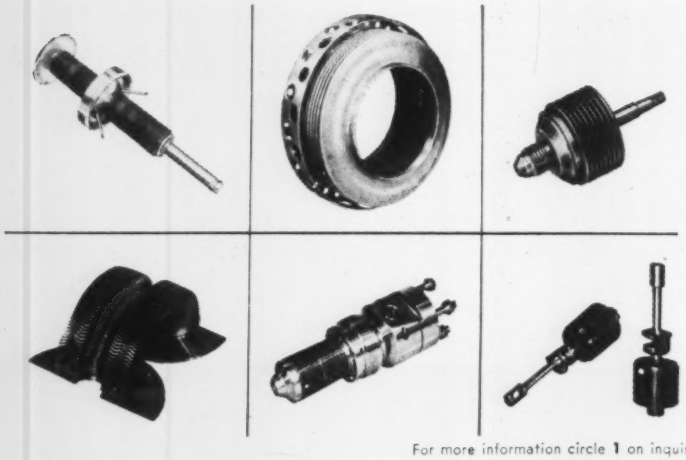
We are solving critical problems in instrumentation, fuel regulation, pressure switches and expansion joints, hot air ducting, pressure surge tanks, packless valves, expansion and vibration joints, oscillating and rotating shaft seals, atomic and nuclear reactors.

Breeze invites your inquiries on bellows jobs *beyond the routine* . . . for the most exacting requirements.



BREEZE

CORPORATIONS, INC.

700 Liberty Avenue, Union, N. J.

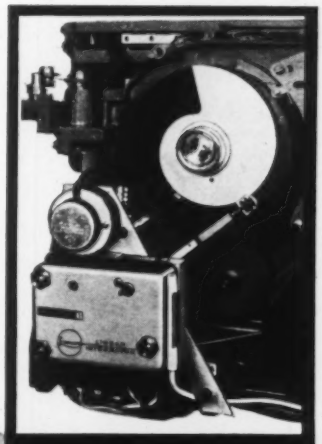
BREEZE MARK

For more information circle 1 on inquiry card.

THE LIBRASCOPE

Model 25 COMPUTING LINEAR INTEGRATOR

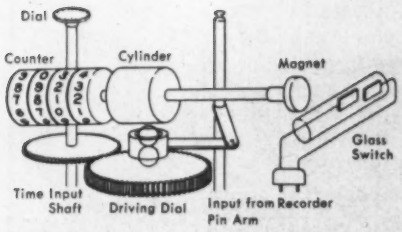
for flow totalization · temperature recording averaging · area computations in gas analysis procedures



Model 25 Librascope Computing Linear Integrator mounted on a Strip Chart Recorder. In this position it accepts the output of the transducer or the recorder pen motion as an input.

Typical Adapter Kit of Model 25 Librascope Computing Linear Integrator with parts. These include baseplate, case, disc, roller, linkages, input shaft, bearings and carriage guides.

Eliminates manual integration
of recording data.
Provides continuous integration.
Direct reading and also remote
reading through electrical impulse output.
Fits all Standard or Miniature
Strip Chart Recorders.



Model 25 Computing Linear Integrator is a *ball disc integrating mechanism* assembled with a counter and an electrical pulse output switch for remote recording.

The Model 25 *Librascope Computing Linear Integrator* is designed to provide a fast, accurate, reliable, continuously integrated total of data as it is being recorded or presented. (The Model 25 Computing Linear Integrator ends inaccuracies of totalizing by eliminating manual integration.) The Model 25 can be installed on any device having shaft rotation or displacements as an output.

SPECIFICATIONS

Accuracy – 1% full scale
Shaft Rotation – 0° – 100°
Range – 0% – 100%
Input Shaft Torque – 0.1 in. oz.
Outputs –
Mechanical counter – 4 digits
Electrical Pulse
DC Volts: 28 – amps.: 0.5
AC Volts: 110 – amps.: 0.5
Size – 3.0"x4.38"
Weight – 1.5 (lbs.)
Computer is sealed against dust.

Computors, Controls, Components

Representatives located in principal cities

LIBRASCOPE
A SUBSIDIARY OF CPE

Librascope, Incorporated • 808 Western Ave. • Glendale, California

For more information circle **2** on inquiry card.

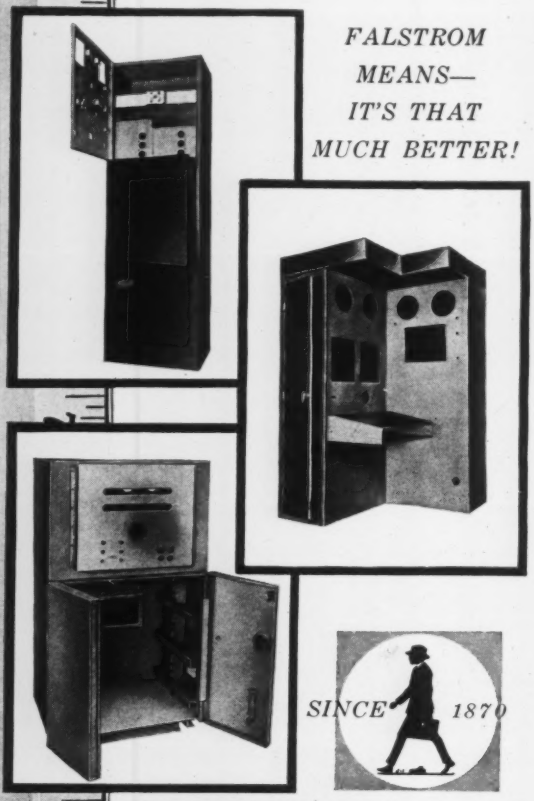
Installation kits are designed to fit any standard or miniature chart recorders.
For detailed information of Model 25, write for Computing Linear Integrator Bulletin just released.

a good rule to follow:

for cabinets, instrument panels, weldments, enclosures, cubicles, housings, chassis, consoles—

see Falstrom!

The measure of any company is its reputation—and for 85 years now, Falstrom has been the outstanding name in the sheet metal fabricating field. Under one roof, Falstrom maintains complete design and production facilities including the latest metal working equipment—all backed by men whose experience embraces every type of enclosure requirement. For all work in aluminum, steel and other alloys write for bulletin 142.



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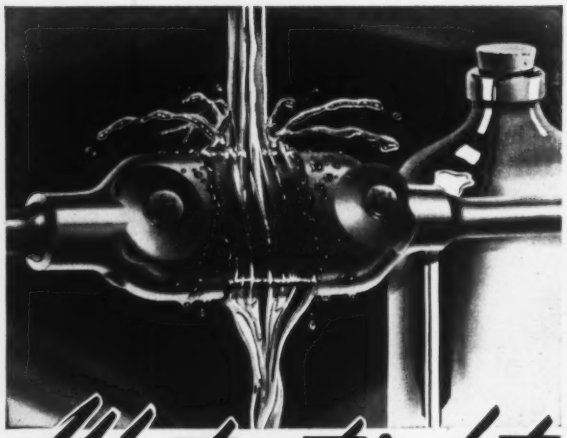

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(2) PUSH-LATCH DESIGN
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(3) ROUND DESIGNS
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(4) OVAL DESIGNS
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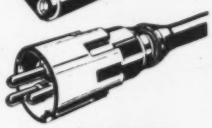
(5) (S.P.B.) DESIGNS
For heavier currents. Have threaded couplings. No. X8223- , illustrated.



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INSTRUMENTS and AUTOMATION

EDITED FOR USERS OF MEASUREMENT AND CONTROL INSTRUMENTS

Volume 30, No. 9
September 1957

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THE MAGAZINE OF INSTRUMENTATION AND AUTOMATIC CONTROL SINCE JANUARY 1928

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Accurate HIGH-SPEED Continuous Telemeter for VOLTS AMPS WATTS VARS ETC.

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Any communication link, including power line carrier, microwave or wire line may be used.

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For more information circle **5** on inquiry card.

Letters to the editor

Editor, I&A:

I was pleasantly surprised last evening when I found your book *Electronic Circuitry* in the mail, after being informed that it was all sold out. After looking it over I decided that I could very well have paid $10.00 for the book and would have received my money's worth.

This book is straight-forward and mature in its presentation. It doesn't bore you in a maze of mathematical gibberish and abstract theory, as do most treatises and textbooks.

Enclosed is a check amounting to $4.00 to cover the cost of the book.

Vernon J. Seibert
Clairton, Pa.

P.S. If you wish to use my letter in your Letters to the Editor—proceed.

The second edition of this book, revised and brought up-to-date, is now on the press. It will be available in 3 weeks at a price of $2.00 (paper bound).

Editor, I&A:

In the April issue of *I&A*, on page 682, you show the two screens of the tubes of the "Hard Bottomed Clock Multivibrator" connected together, but no connection to any voltage source. Is that a mistake?

I would like to adapt that circuit to produce square pulses of low repetition rate (8 to 20 pps) with accurate controllable percent on and off portions of the cycle.

Ernesto A. Martin
N. Y. 61, N. Y.

The screens of the multivibrator tubes are returned to B plus via the 220K resistor shown at the left of the illustration. The drawing is not very clear on this point, but it does show this connection if you look closely (page 682, *I&A*, April). The circuit should work nicely for 8 to 20 pps with modification of the RC constant via either the pots or the capacitors shown. A transistor multivibrator circuit (Circuit 52) and other circuits are given in the book *100 Electronic Circuits* by Aronson and Kezer, which has the first 100 circuits in this series of articles. It is available for $2 from this organization.

A Letter from Costa Rica:

Editor, I&A:

The May 1957 (Vol. 30 No. 5) issue of *Instruments and Automation* has arrived, and we were very much interested in your editorial on education. We thought, however, that you would be surprised to learn that down here in this Caribbean Republic, we have jumped the gun on you by almost eight years on that business of a committee for technical education, and in getting courses started with a strong emphasis on measurement. I am enclosing a copy of our latest flyer relating to this school, which was founded in October, 1949. However, before I begin telling you about the school, I will review back notes about my acquaintance with *Instruments*.

Way back in Nov. 1905, I was born in this city of San Jose. Very early I began to manifest "instrumential" tendencies. By 1922 I had become an authority on automotive battery ignition systems. And in 1924, I entered engineering school at Cornell. By 1935, *Instruments, The Magazine of Measurement and Control*, had the as-yet-unheard-of privilege of publishing in its August issue my learned opus: "How the Reynolds Number Originated and How to Compute Its Value." Since then I became a sort of "reader emeritus" of your publication.

In order to describe our school, I have to tell you first about the general background and conditions here, because most people in the U.S. are full of misconceptions about Latin American countries. This little country began as a 100% agricultural community. We have a geographic area of about 20,000 sq-miles, but most of it is incapable of being settled for various reasons. The central valley, with only 1000 sq miles, has more than half the total population of around 1,000,000. That means a population density of about 600 per square mile. Land is therefore very expensive, and it is impossible to maintain a decent standard and be able to have things—if we had to depend on agricultural exports.

Thus we are becoming an industrial nation, and already only 27% of the people of the province of San Jose dedicate themselves to agriculture. Our biggest and most valuable resource is easily developable water

power. Unfortunately, it requires large blocks of capital to make the developments, and we have had very bad luck with foreign financial groups, like the Electric Bond and Share who tried to exploit us in a lousy manner. In that and other things we had to gradually develop a new form of government, which we may call a government based on "autonomous entities." An autonomous entity is an organization like a private corporation, but its assets are the country's property. To keep politicians out, the directors that comprise the board are appointed in staggered fashion, each for a nine-year term. Thus no administration can "pack" the board with its henchmen. We have one that runs all insurance in the country, and at the same time administers all the fire departments. Others administer banking. The Pacific railroad is run by another. There is another that administers the distribution (not the production, which is a matter for farmers) of foodstuffs and sees to it that no violent price fluctuations occur. Of the two new ones, one is engaged in large-scale low-cost home construction (about 400 new houses have been built this year) and the other in developing hydroelectric resources. This latter one has just finished a 12,000-kva diesel plant for peaking and standby, and is finishing a 30,000-kva hydro. Of the latter, about ¾ of the power will go for residential and rural electrification, and the rest to push the development of small local industries.

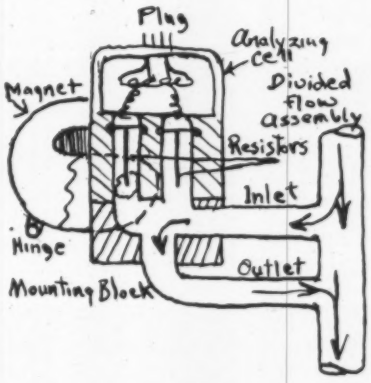
All these things naturally require workmen with technical knowledge. This little country has always prided itself on its progressive interest in education and on the fact that "it has more school teachers than soldiers." However, the high-school system has a strong classical tradition and French influence behind it. This was all very fine when the country was 100% agricultural, and the high-school teacher was engaged in teaching the sons of the landed aristocracy all about the classical culture, the transcendental values, and the absolute "absolutes" of the French philosophers. But when I started dabbling in educational problems, my quaint "instrumentician" background quickly sniffed the fact that in spite of the 5000 students we had in high school, workingmen families were NOT sending their sons to high school! In other words, our educational system, though ample, is a highly selective one socially that does not reach down into many places it should. The ministry of education, baffled by all

RAMBLINGS ON INSTRUMENTATION

How to Build O_2 Analyzers for Fun and Profit—Step 2

This is the second in a spasmodic series of do-it-yourself instructions for those who are either too proud or too poor to buy their oxygen analyzers from Hays, but still want nothing but the real, finicky Hays construction. Our first lesson, termed by some loyal readers "the best tranquilizer they've come across," told how anyone with a little skill and working capital can amaze their chums with genuine Hays-type precision sensing elements.

Our next step is to mount these two elements within an analyzing cell (see artist's impression below). Cram in two more precision resistors to complete a standard Wheatstone Bridge (named for its inventor, Sir Wheatstone Bridge, Cambridge '01). Bring the leads out the top at some convenient point. Don't forget to seal the upper end of the two chambers so that gas cannot flow through them. This prevents dust or moisture from settling out, a problem with other designs.



Put the cell on a mounting block, being careful to provide an inlet and outlet for the gas. Diffusion will bring about an exchange of gas within the cell block itself.

Now get hold of a 3300 gauss plus Alnico 5 magnet of at least 20 pounds weight (watch your paper for sales). Stabilize this at about 2500 gauss and mount it on a hinge so it can be swung away from the analyzing cell for zero checking. Now you're ready to fire up. Better wait for our next lesson for this (or write for our bulletin 56-829-56 to bone up). Should you decide to go it alone, lots of luck.

Our ad manager, who yearns for a good old hard-sell product ad now and then, insists that, while we're rambling about O_2 analyzers, we include a reference to our Mark II analyzer available very soon. It incorporates the divided flow assembly shown here. Only a small portion of the total gas actually passes through the analyzer. This maintains high response to sample changes, yet holds down possible damage caused by particles of foreign matter bounding through the system.

For do-it-yourself fans, we have a conversion kit available to bring your instrument up to date. It includes parts, step-by-step instructions, drawings and three Band-Aids. We'll be happy to send you details.

How to Get Off a Tenterhook

Our bated-breath bulletins concerning the new Hays Universal Recorder have fanned a flame of curiosity among recorder enthusiasts everywhere. While we still can't sell you one, darn it, we'd be very happy to show you our new baby in the flesh at our exhibit at the ISA Show in Cleveland. We're in booth 1013. Drop in.

HLP! HLP!

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the difference

between

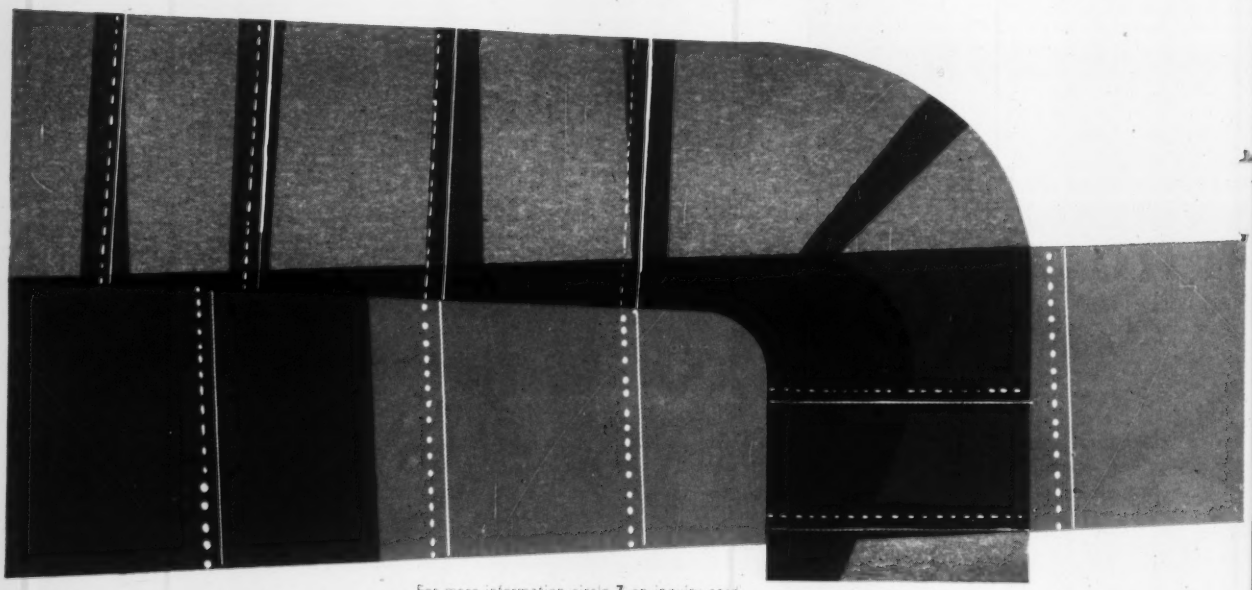
profit and loss

CHROMO MAX

your key

to process

stream analysis



For more information circle 7 on inquiry card.

Probing deep into the heart of process streams, the Chromomax can be the difference between profit and loss. This new advance in gas chromatography instrumentation will be of vital interest to engineers and plant managers alike. An analysis by Chromomax brings into focus the variations of all stream components which contribute to profitable or to unprofitable plant production.

Chromomax will first be introduced at the I. S. A. Show in Cleveland. If you don't plan to attend, write us at 4995 Stenton Ave., Phila. 44, Pa. and ask for Folder ND46-91(7).

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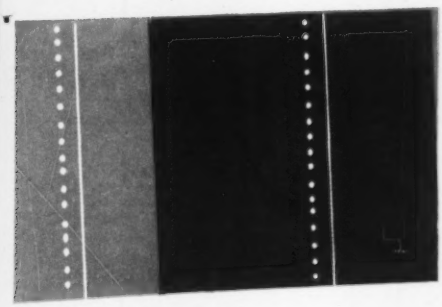


For more information circle **7** on inquiry card.

LETTERS—CONTINUED

these problems, appealed to international agencies like UNESCO, Truman's Point Four, etc. All these sent experts who made elaborate "surveys," studies, reports, etc. But they left themselves (and us) as baffled (or more) than we were before.

As I am strong for the "experimental method" I decided that the thing to do was to get a school going and then gradually work out the details as we went. I called up about twenty acquaintances in concerns for whom I do consulting work, and each one pledged a small monthly sum. This "endowment fund" of around $45.00 per month US began to pay for two instructors. Then I made a "sociological" study of my own, asking by means of a questionnaire to managers and other people who use the products of education, what a school should teach. This gradually led to the development of our basic science course.

We tell the student: Modern civilization is fundamentally a *quantitative* culture. This does not mean that you have to quit being a good Roman Catholic, nor even to forsake the fine qualities of independence and individuality that you inherit from Don Quixote, but it does mean that you have to learn to think quantitatively if you desire to become a competent and efficient workman. From there on they delve into a textbook we are gradually evolving: "Las tres unidades fundamentales de la ciencia moderna son: Largo, Masa, y Tiempo" . . . Later on they begin to discover that "largo" combined with tiempo gives "velocidad." And that "la presion" es una "fuerza" entre una "area." By the end of the second year most of the boys are aware of the fact that a kilowatt is not the same as a kilowatt-hour. Under the present program, the boys of the Basic Course attend 10 hours of classes of night school per week (three general science, three math, two mechanical drawing, two Spanish composition). In the second year they take algebra, physics, chemistry, electricity, mechanical drawing, and more Spanish composition. In the third they delve into electronics, topographical surveying, and the specialized courses to fit them for specific jobs in local industries and in departments of the previously mentioned autonomous agencies.

As a textbook in the second year the boys get a Spanish translation of *Physics for Science and Engineering* by Weber, White, Manning and Febrer, which they use in both the mechanical physics course and as an electricity text. You will be delighted to know that our instructors have also gotten a lot of inspiration out of Basic Navy Training Courses and "Electricians Mate-2" which, we understand, were written by a certain Senor Aronson, now editor of *Instruments & Automation*.

At first we were very limited in space. The only two halls we had to work in were loaned to us by the Engineer's Society here. I spotted an old building with a four-story tower that formerly belonged to the museum. It had been declared uninhabitable because earthquakes had cracked the brick arches above the windows, and theoretically it should have collapsed—but it hadn't yet. I convinced the Minister of Education that if we put iron rods around it like a barrel hoop, it could stand quite an earthquake (probably a horizontal acceleration of 0.005 g). Well, anyway, he did not say it, but he figured that if an earthquake came, the one who would be crushed would be Raff, Keith and his crazy disciples; so he handed over the tower for our use.

Next to the tower were some larger rooms used by a governmental agency. One day Agency #1 started to move out. Before Agency #2 moved in, I barricaded the doors and put up a very eloquent Philadelphia lawyer's argument to the effect that the two rooms were part of the tower, but that we, being very gracious, had loaned them to Governmental Agency #1 as a gesture of cooperation, but now we needed them. Well, there was also a large open lot at the base of the tower, for which the lawyers of three governmental agencies have been fighting among themselves during the last twenty years or so. Our mechanical drawing instructor put the students to design a prefabricated structure—trusses, columns, purlings, etc.—which we built in dark secret. One clear morning, starting at 6:00 a.m., a building 46-feet long by 20-feet wide suddenly seemed to bloom on the lot. And before the lawyers could get an injunction ordering the construction stopped, the roof was on and a padlock on the door. Next morning the Chief Justice of the Supreme Court of Costa Rica and two magistrates dropped in to see for themselves. They were fascinated at how little the structure had cost, and finally decided that juridically nothing could be done to what in French they call *fait-accompli*. I tell you all these things so you can get a little

SANDERS
Model 2 Phase Comparator

...can be used as a modulator, demodulator or switch

This compact, rugged comparator is hermetically sealed in an inert gas and packaged for mounting in a standard octal socket. Two full-wave bridge rectifiers are used to obtain a high degree of stability and balance.

As phase sensitive comparators, these units can be used to measure the amplitude or phase of an input signal with respect to a reference signal. As demodulators, DC output can be obtained either single-ended or push-pull with respect to ground. Suitable for all military applications.

SPECIFICATIONS

Frequency Response: 0 to 5000 CPS; ***Max. Reference Voltage:*** 120V. RMS; ***Max. Output Voltage:*** ± 50V. DC; ***Dynamic Range:*** 46db; ***Load:*** Max. 200K ohms, — Min. 20K ohms; ***Input Impedance:*** Approx. 200K ohms with 200K ohms load and 1:1 transformer. ***Size:*** 1″ dia. x 3″; ***Weight:*** 2 ozs.

Write for data sheets to Dept. H

SANDERS ASSOCIATES INCORPORATED
Nashua 9, New Hampshire

For more information circle **8** on inquiry card.

LETTERS —CONTINUED

of the local flavor, especially the fact that there is never a dull moment around here.

The building we now have is bigger, taller, and considerably more substantial than what Harvard had in 1636. We are growing at the rate of about 30% per annum. The $45.00 per month endowment has now grown to about $800.00 US per month, counting student fees. The boys pay the following: Basic Course: $0.53 US per week for 10-hours class. Advanced courses: $1.40 US per week including lab fees. The instructors get paid about $1.60 US per hour of class given. They have to correct papers and prepare instruction sheets on their own time.

The local U.S. Embassy, representing the U. S. State Department, loaned us a filmstrip projector, several filmstrips and also gave us publications for the library. They have also spent an estimated 6,432 manhours trying to discover our connection with the Russian government (those who never have been bitten by the "instrumental" bug cannot conceive why otherwise sane and reasonable people work like mad at Escuela Tecnica). As you can also see from our bulletin, we are not troubled by matters of racial segregation, as all those things got settled here by a pastoral letter issued by Fray Bartolome de las Casas around 1540.

We also would like to receive from you examples of lab exercises in basic measurement, electricity, physics, etc.; also bulletins describing the technical high schools of Pittsburgh; also pictures of labs and shops.

Rafael W. Keith
San Jose, Costa Rica

There is more to be learned from this "letter to the editor" than from many books on education and Latin America. Here is a vivid and profound description of a boot-strap operation by a pioneering and dauntless entrepreneur of a type not often seen. As lengthy as is this letter, there is much to be learned from between the lines.

Mr. Keith will receive all details of the Pittsburgh instrument-automation course, including lab work and text material, as they develop. But perhaps we have more to learn from him than vice versa. Our approach to our own problems here in the USA is too often to set up a committee or foundation dedicated to planning and talking, rather than acting and helping.

Reader Inquiries

Company Identification

Instrument engineer in brewery wishes to identify company specializing in flow control of viscous liquids by controlling temperature. Name is believed to be similar to Fluid Systems, Inc. A-257

Milliampere-seconds Meter

Mexican reader wishes to receive technical data on principles and performance of "MAS" (milliampere-seconds) instruments. A-258

Linear Footage of Strip Steel

Manufacturer of electromechanical devices seeks information on measurement of strip steel passing a certain point "by devices not touching the steel." A-259

Constant-tension Winding

V.P.-Development of glass manufacturer is interested in finding device to maintain constant tension in 26-ga steel wire being fed from spool to weaving machine. A-260

High-accuracy Scale

Purchasing engineer in large electrical concern wishes to buy scales for weighing control samples of treated paper and cloth to an accuracy of plus or minus 0.01 gram. Sample sizes: 6″ x 6″ and 3¼″ x 3¼″. Hand-adding of weights preferably to be avoided. Range: 0-50 grams. Slight amount of dust present in non-air-conditioned stations. Instruments can be hooded to prevent air currents. A-261

Thermo Timer; Bi-metals

Reader, working on inventions, is anxious to get information on thermo timers; also literature on bimetallic metals for thermostats. A-262

Simulation of Storage Battery

Control engineer in electric-locomotive department of large manufacturer requests information on simulation of a lead-acid storage battery on an analog computer. A-263

Market Place

Patents to be Licensed

Patent holder of electric automatic pressure cooker and electric automatic heater, also of gas-and-electric pressure cooker and automatic heater will license his inventions to interested parties. Write to Market Place, c/o Instruments Publishing Company, 845 Ridge Ave., Pittsburgh 12, Pa.

MASON-NEILAN

Brings 75 Years' Experience to the Advancement of

See Masoneilan Equipment in Action at the I.S.A. Exhibit... Cleveland, Sept. 9-13, Booth 1332

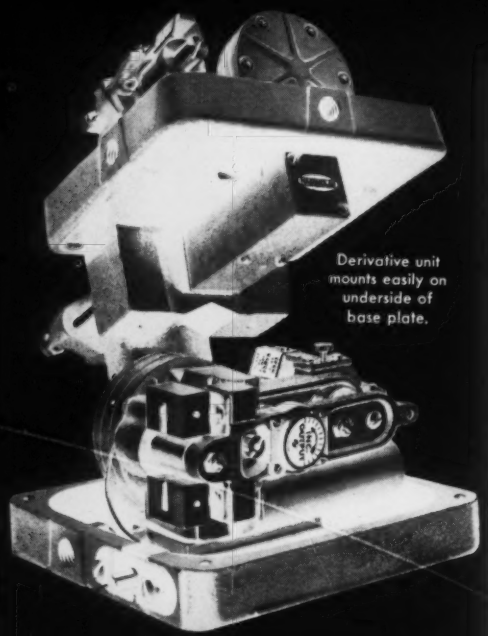
For more information circle 9 on inquiry card.

NOW...

for one of the latest results of Mason-Neilan's product development program

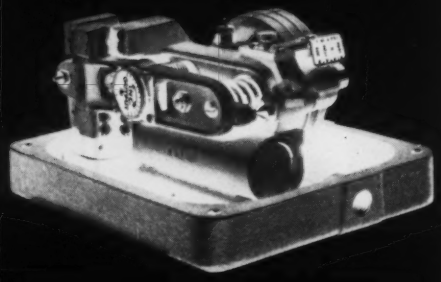
TURN THE PAGE

NEW



Derivative unit mounts easily on underside of base plate.

All adjustments are readily accessible, visible and easy to make.



Special "Balanced Beam" design permits mounting in any position without zero shift.

MASONEILAN TEMPERATURE TRANSMITTER

Distinguished by Exclusive Features

Important design differences in this newly developed force-balance transmitter offer advantages in accuracy and dependability. For example:

- **Balanced Beam** design permits mounting in any position without zero shift.
- **Unit subassembly** construction permits removal (for change of range, replacement or maintenance) of thermal system; compensating bellows; feedback bellows; pilot; range span adjustment assembly; derivative unit; gasketless nozzle — any or all without disassembling beam assembly in any way.
- **All adjustments visible and accessible** without disturbing any other part of the mechanism. Range span setting is unaffected by vibration.
- **Protection against damage** is provided for thermal system by a beam stop and the overrange feature; for compensating bellows by built-in stops; for entire unit by rugged weatherproof case.
- **Indicating Receiver Gauge** may be installed directly in manifolded base plate — no piping or tubing required.

A Pressure Transmitter, Too: The temperature transmitter may be readily converted to a pressure transmitter by substitution of a pressure element for the thermal system (within limits imposed by pressure conditions and characteristics of measured fluid).

Write for bulletin or secure details from our nearest office.

MASONEILAN

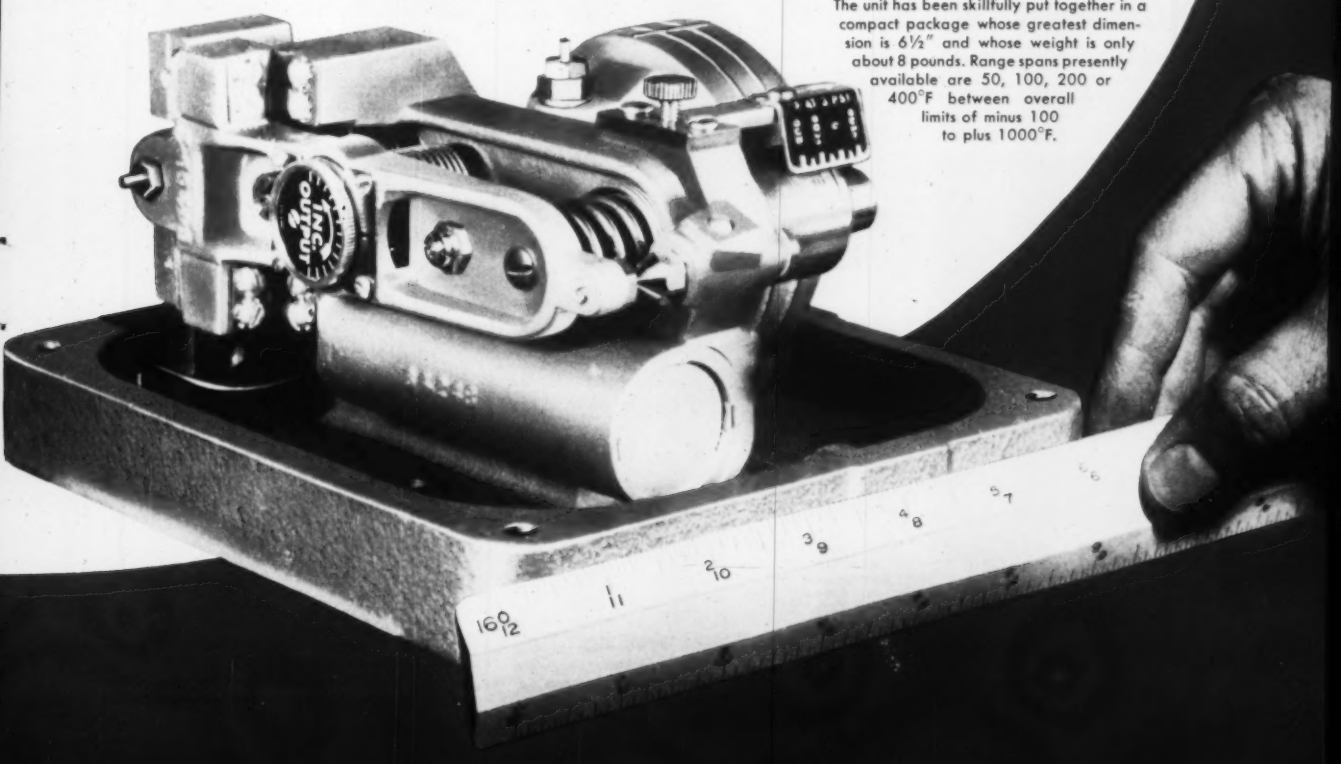
MASON-NEILAN

Division of Worthington Corporation

55 NAHATAN STREET, NORWOOD, MASSACHUSETTS

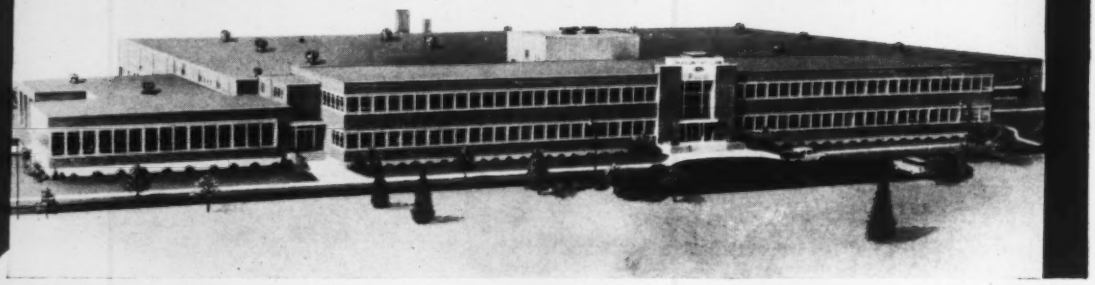
SEVENTY-FIFTH 75 ANNIVERSARY 1882 1957

For more information circle 9 on inquiry card.



The unit has been skillfully put together in a compact package whose greatest dimension is 6½" and whose weight is only about 8 pounds. Range spans presently available are 50, 100, 200 or 400°F between overall limits of minus 100 to plus 1000°F.

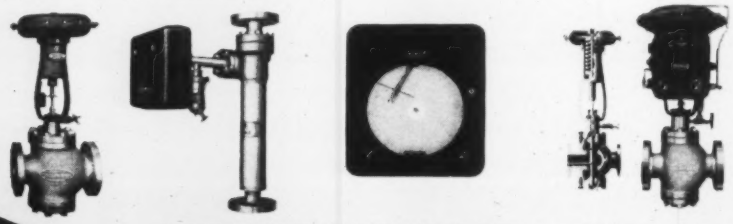
New Mason-Neilan Plant and Offices in Norwood, Mass.



Greatly increased and growing facilities of our new plant permit acceleration of product development for the advancement of

PROCESS CONTROL

to meet the requirements of expanding and increasingly control-conscious industry. New, or improved, realistically-engineered products, now in various stages of development are scheduled to join the Mason-Neilan quality line.



MAJOR MASONEILAN PRODUCT GROUPS, Control Valves • Liquid Level Controls • Pneumatic Controllers • Regulating Valves and Auxiliary Equipment

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DATA FOR DESIGN

From missile and aircraft design to power network analysis, the ALWAC III-E digital computer offers substantial savings to users. The versatility of this economical, medium-size data processing system affords management peripheral benefits in payroll, cost analysis, accounting, billing, and file maintenance.

For specific applications information call ALWAC today, or visit the ALWAC computing center in New York City or Hawthorne, California.

An ALWAC III-E will be installed and operating at the I. S. A. Instruments-Automation Show, Cleveland, Ohio, September 7-13

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Astounding

NEW
PERFORMANCE

MIDWESTERN

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OSCILLOGRAPH

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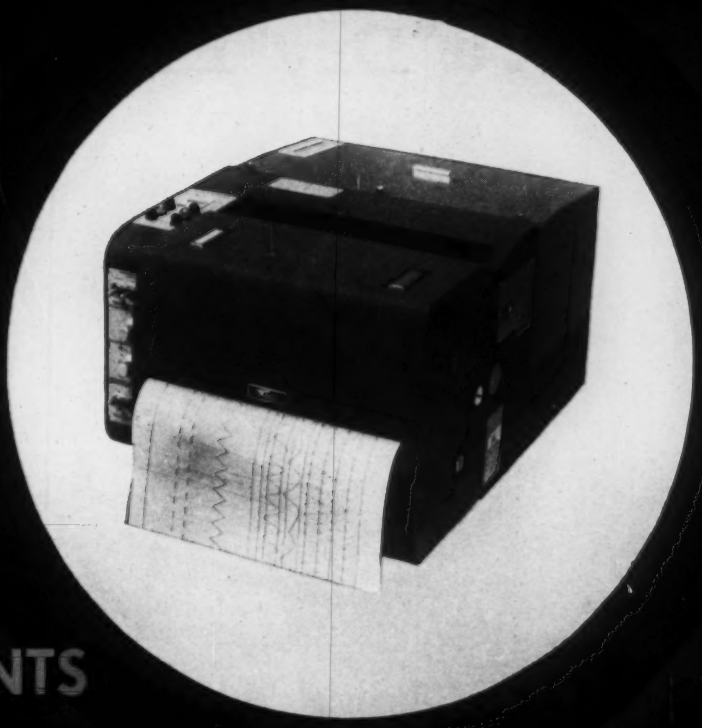
*DIRECT READOUT WITHOUT PROCESSING
SELF-DEVELOPING • DRY • NO CHEMICALS

SPECIFICATIONS

MAXIMUM NUMBER OF CHANNELS	50 Channels
RECORD WIDTH	12 inches
MAGAZINE CAPACITY	200 feet
RECORD SPEED RANGE	0.0812 to—129.9 inches per second
FREQUENCY	dc to above 3,000 cps
WRITING SPEED	Above 30,000 inches per second
OPTICAL ARM	11 inches—
POWER REQUIREMENTS	115 Volts—60 cps
TIMING LINES	0.01 and/or 0.10 second intervals
SIZE	11 1/16" x 16 13/16" x 24 1/2"
WEIGHT	130 pounds

For more information circle 11 on inquiry card.



5 EXCLUSIVE ADVANCEMENTS

- *Up to 50 channels of information*
- *Uses standard 102 Galvanometers*
- *Provides timing lines, record numbering and many other advancements*
- *30,000 inches per second writing speed with excellent legibility dc to above 3,000 cps*
- *Seven inch or twelve inch records*

Wire for Brochure: **FAX-FCB/TULSA**

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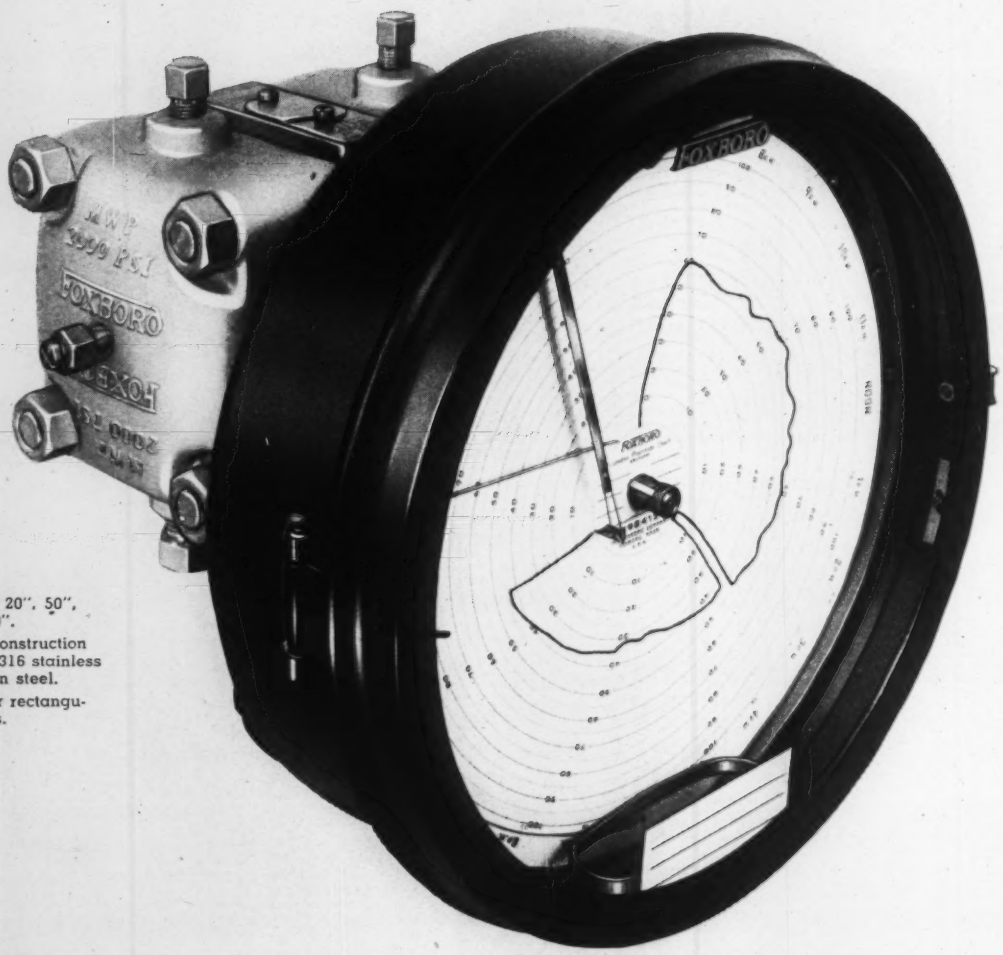
INSTRUMENTS

P. O. BOX 7186 TULSA, OKLAHOMA

For more information circle **11** on inquiry card.

NOW... a "Dry" Flow Meter with ..

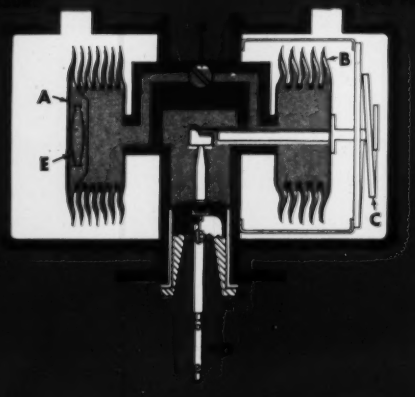


- Ranges: 20", 50", 100", 200".
- Forged construction in Type 316 stainless or carbon steel.
- Round or rectangular cases.

...the new Foxboro Type 37 Diaphragm Meter

How It Works

In schematic drawing at right, areas shown in color represent a stable, non-freezing liquid. Any pressure increase in the high pressure chamber compresses Diaphragm Unit A, displacing its liquid and expanding Diaphragm Unit B until force of Range Spring C equals the difference between the forces on Diaphragm Units A and B. Linear motion of Diaphragm Unit B moves inner end of Drive Bar D — outer end moves correspondingly through the bellows-sealed flexure bar, driving pen arm. Built-in Temperature Compensator (E) proportionately adjusts diaphragm capacity as ambient temperature variations affect volume of filling fluid. External damping adjustment is shown at F.



• complete overrange protection!

• sustained high accuracy!

Now you can have mercuryless flow measurement for a wide range of differential pressures — at static pressures up to 2000 psi — with greater safety and dependability than ever before!

The new Foxboro Type 37 Diaphragm Meter not only combines unmatched ruggedness and precision in a dry meter — it's by far the easiest to adjust and maintain. And it does away with zero drift problems, once and for all!

Expansible, Type 316 S.S. diaphragm elements respond to changes in pressure with unmatched sensitivity, yet are completely immune to overrange up to full static pressure! A unique packless drive bar precisely transmits linear motion to the pen arm. Range-changing is easy, due to new twin-spiral spring design. Wide range damping is externally adjustable under pressure. And the Type 37 is self-compensating for temperature changes in all differential ranges.

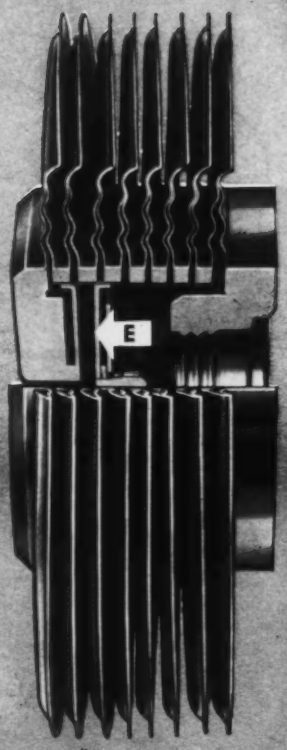
Get full details on this high utility, completely dependable dry flow meter. Arrange for a demonstration with your nearby Foxboro Field Engineer, or write **The Foxboro Company, 469 Norfolk St., Foxboro, Mass., U.S.A.**

FOXBORO

REG. U.S. PAT. OFF.

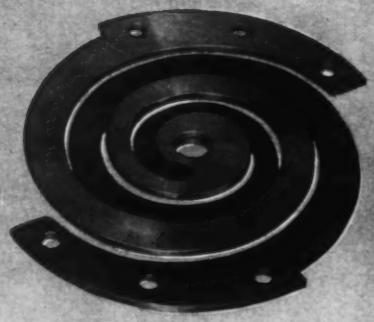
FIRST IN FLOW METERING

For more information circle **12** on inquiry card.



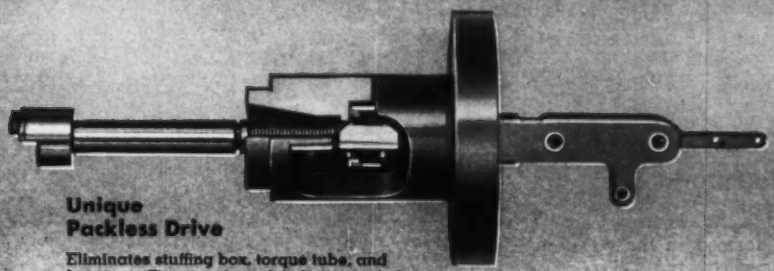
Exclusive Diaphragm Elements

Type 316 S.S. diaphragm units in both high and low pressure chambers provide greatest linearity and freedom from hysteresis; nesting design and integral spacer rings provide safe, positive, overrange protection. Temperature compensation (E) is built into diaphragm assembly . . . never requires change or adjustment.



Exclusive Range Springs

Heavy gauge Ni-Span C alloy, twin-spiral springs provide high sensitivity with lasting accuracy. Readily accessible . . . range changes are easily made, in minutes!



Unique Packless Drive

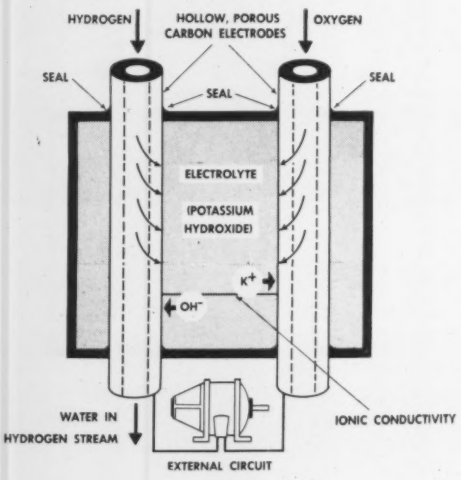
Eliminates stuffing box, torque tube, and bearings. Flexure-pivoted, bellows-sealed drive bar transmits diaphragm's linear motion to the pen arm with unequalled sensitivity and undiminished power. Seal for flexure pivot is a tough, flexible bellows.

News

Electricity From Gases Now Practical

PARMA, OHIO—The direct conversion of the chemical energy of gases into electricity—long a dream of scientists and for years a laboratory curiosity—has been accomplished with the development of the first fuel cell capable of economically producing thousands of watts of power. Using hydrogen and oxygen as fuel, the new silent source of power has been developed by scientists at the Research Laboratories of National Carbon Company, Division of Union Carbide Corporation.

First significant application of the new fuel cells is in providing silent electrical power for the U. S. Army Signal Corp's new "Silent Sentry." The world's smallest known radar set, the lightweight, portable unit provides mobile Army forces with local combat surveillance of enemy movements despite smoke, darkness, or fog. A battery of National Carbon Company fuel cells provides



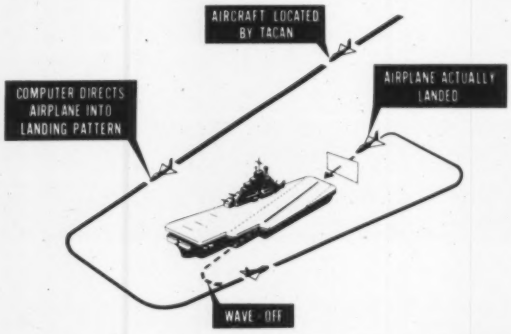
power to operate the radar set at the U. S. Army Electronic Proving Ground at Fort Huachuca, Arizona.

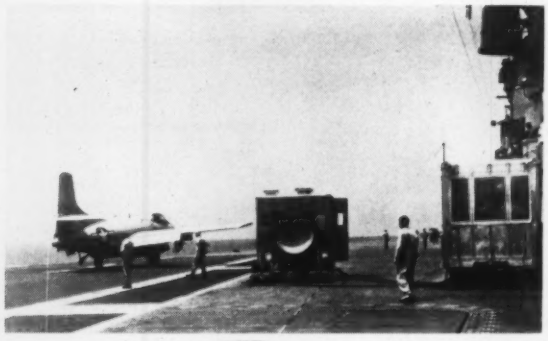
"Secret of the new fuel cell's success," Dr. C. E. Larson, National Carbon's research vice president, said, "is the chemically treated, hollow, porous carbon electrodes through which the gases enter the cell, and which also conduct the electricity produced by the reaction."

Simplified drawing illustrates the basic operation of the fuel cell. Hydrogen and oxygen gases enter the cell through specially-treated, hollow porous carbon electrodes, and diffuse to the surface, where they come in contact with the electrolyte, a solution of potassium hydroxide. At the hydrogen electrode, the electrochemical reaction releases an electron, which flows through the external circuit and is accepted at the oxygen electrode. This flow of electrons is the current that powers electrical equipment. Ionic conductivity through the electrolyte completes the circuit, and the water formed in the reaction passes from the cell in the hydrogen stream.

Automatic Landing System Passes Tests

ABOARD USS ANTIETAM, PENSACOLA, FLA.—Automatic landing of Navy jet aircraft, using a ship-based automatic plane control system combining a fire-control-type radar, a data link, and an analog computer, was demonstrated to Navy and Air Force officials, Bell Aircraft Company officials, and members of the press aboard the USS ANTIETAM, August 20. The new Automatic Carrier Landing System (ACLS), developed by Bell Aircraft (the prime contractor) under Navy and Air Force Contracts, utilizes in its shipboard form (the An SPN-10) a unique ship-motion prediction circuit which accurately forecasts the position of the ship's arresting cables at the moment of touchdown. Mr. Franeuf, President of Bell Aircraft, said that original research on a number of seagoing ships having different pitch and roll characteristics was necessary to determine the circuits of the predictor, which have been classified by the Navy.





The automatic landing system provides automatic wave-off if the plane's speed or the ships position is unsuitable for landing at the moment of contact. Also, the pilot can override the controls to regain direction of his plane at any time. Equipment in the jet for automatic landing consists only of the auto-pilot and the data-link transceiver, both standard equipment in Navy carrier planes.

Installation of the test equipment aboard the carrier was facilitated by incorporating the radar, power supply

Continued on page 1643

Circle **13** on inquiry card.

Get Your Own *B-NOBATRON!*

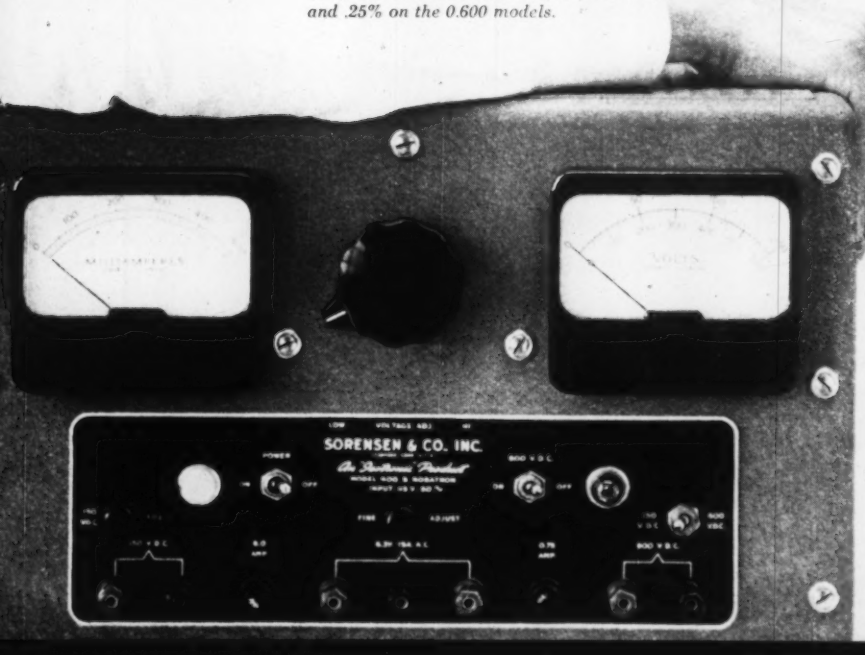
Multipurpose B-Power Source Available in Five Models, Ranging from 300 to 1000 VDC Tops; Low Ripple, Accurate Regulation; Provide Filament and Bias Current in Addition to High Voltage Output.

Here's the economical and lasting answer to B-Power supply needs for nearly every laboratory, and many industrial operations. Nobatrons are built to last, and serve without maintenance. Damage to the Nobatron and its load is prevented by input and output fuses. Five models offer ranges of: 0-300 VDC, 0-325 VDC, 0-500 VDC, 0-600 VDC, and 200-1000 VDC. All but the largest model deliver 6.3 volts for filament supply and all but the 300-B and 1000-BB offer 0.150 volt regulated bias.

Regulation accuracy is within a maximum tolerance of .5%*, and ripple is held to five millivolts RMS or below (except for 20 mv. maximum on the 200-1000 VDC model). Input range is 105 to 125 VAC, with frequency of 50, 60, or 400 cycles. B-Nobatrons may be used in either cabinet or rack mountings, and are a handsome contribution to their quarters. Your local Sorensen representative will be glad to tell you all about these B-Nobatrons. Write directly for technical data, to

SORENSEN & COMPANY, INC. Richards Avenue, South Norwalk, Connecticut

**Only .15% maximum variation on the 0-300; and .25% on the 0-600 models.*



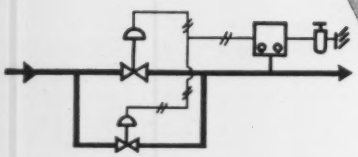
SPECIFICATIONS

Model	300B*	325B	500B	600B	1000B
Output Voltage VDC	0-300	0-325	0-500	0-600	200-1000
Output Current Ma	0-150	0-125	0-300	0-500	0-5000
Regulation Accuracy	±0.15%**	±0.5%	±0.5%	±0.25%	±0.5%
Ripple (MV-RMS)	5 max.	5 max.	5 max.	3 max.	20 max.
Bias Supply (VDC)	—	0-150	0-150	0-150	—
Max. Bias Circ. Imp. (Ohms)	—	25000	25000	50000	—
Max. Int. Imp. (Ohms)	2.0	2.0	2.0	2.0	2.0
AC Voltage (CT Unreg.)	—	6.3/10 amps	6.3/10 amps	6.3/15 amps	—
Filament Voltages (Unreg.)	6.3 at 5 amps, series or parallel (two outputs)	—	—	—	—

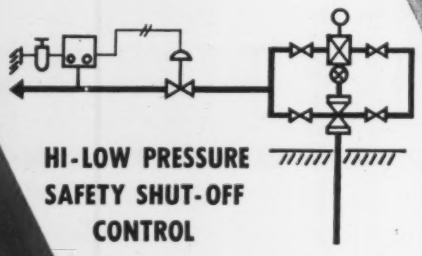
**may be connected positive or negative, in series or parallel*
***or ±0.3 volts, whichever is greater*

For Optimum Pressure Control, Specify BS&B 72-14 Pressure Controllers And Transmitters!

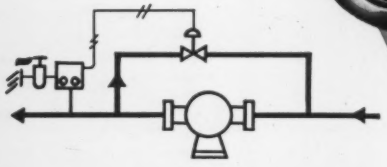
Proportional * On-Off * Differential Gap
Indicating Or Non-Indicating



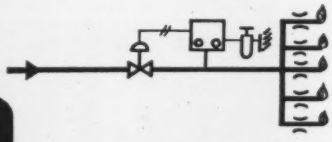
PRESSURE REDUCING CONTROL



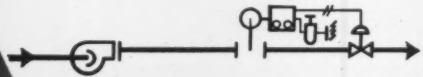
HI-LOW PRESSURE SAFETY SHUT-OFF CONTROL



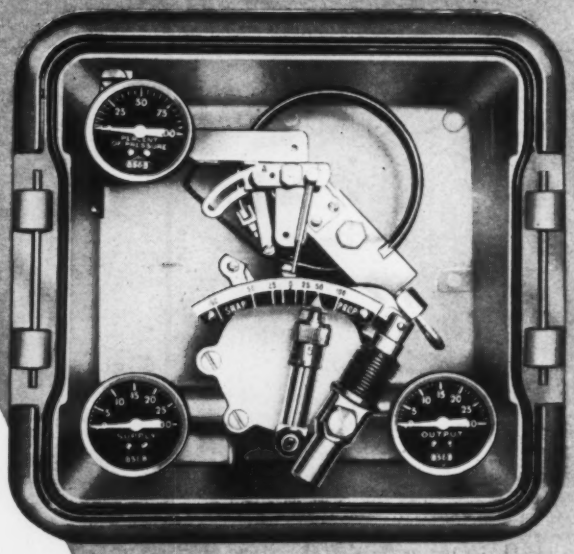
BACK PRESSURE CONTROL



LOW PRESSURE CONTROL



DIFFERENTIAL PRESSURE ...FLOW CONTROL



FEATURES OF POWER UNIT:

- Three-To-One High Capacity Relay
- Vibration Proof
- Push Button Cleanout
- Factory Calibrated Feed-Back Bellows
- Micrometer Adjustment

Ask Your BS&B Sales Engineer For Full Details, Or Write For Catalog 72-14.

OVER 60 YEARS BS&B
ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

BLACK, SIVALLS & BRYSON, INC.

Controls Division, Dept. 4-V9
7500 East 12th Street
Kansas City 26, Missouri

For more information circle **14** on inquiry card.

and stable elements in one trailer, while the data link, REAC computer, and extensive monitoring equipment necessary for recording test results were housed in a second trailer. Any future production model installed on shipboard would take much less space, with the radar antenna mounted on the island, thus utilizing the ship's stable element and eliminating test monitor equipment. The Reeves Instrument Co's REAC computer, which was used in its standard form to provide maximum latitude in test and development, was found more than adequate for all types of plane approach paths—from the linear powered approach used by carrier planes to the flared-type landing favored by the Air Force and commercial planes. The production model will be a simplified unit.

Reeves Instrument Corp., a subsidiary of Dynamics Corp of America, provided not only the REAC computer but also the radar antenna drive system, which uses a stabilization unit with two IG gyros and 20 resolvers.

High compatibility between the automatic landing system and all present approach control systems is claimed. The Automatic Landing System can team up with ILS, GGA, CCA or TACAN to provide complete instrument control from initial contact by surveillance radar to touchdown on the runway or flight deck. One added feature needed in a suitable Air Force landing system will be the inclusion of a taxie guidance system after the plane is on the runway. This is not needed by the carrier landing system.

The Navy Test pilot, CDR Don Walker of the Naval Air Test Center, Patuxent (the agency conducting the test) goes down in naval history as the first pilot to make "handless" landings. He said that after a week of flying with the system he considered the new Automatic Landing System the most exciting development he had witnessed in Naval Aviation. "We have the ability to fly off carriers in zero visibility, but even with carrier controlled approach (CCA) we needed 100 feet visibility over the deck to land. Now we can land in any weather, day or night."

Owen Fairchild

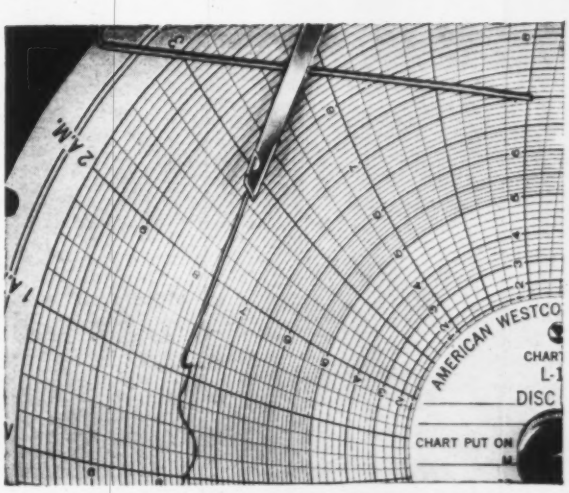
Charles Owen Fairchild—called Owen by his many friends—died on August 22, aged 67, at his residence in Fairfax, Virginia, near Washington. He was one of the greatest Americans in the fields of pyrometry and ceramics.

Perhaps his fame rested most securely on his co-authorship of the National Bureau of Standards book *Pyrometric Practice* (1920). His two collaborators were Paul D. Foote who later became Research Director of the Gulf Oil Co., and T. R. Harrison who later became Research Director of the Brown Instrument Co. He himself left the Bureau in 1926 to become Research Director of the C. J. Tagliabue Mfg. Co., leaving in 1946 when Tag was absorbed by the Weston Electrical Instrument Corp.

During these twenty years he invented the first American photoelectric self-balancing potentiometer recorder-controllers, and then he invented modifications from year to year as competition inevitably appeared and grew stronger.

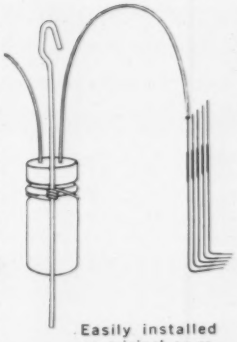
Since 1946 he had been a Consulting Physicist for several industries; the last few years in U. S. Government service.

Fairchild is survived by two brothers and two sisters.



CANNON PENS

assure legible charts ...eliminate inking problems



Cannon controlled-flow capillary meter pens provide exceptional dependability and long life with minimum maintenance. Easy to install, these precision pens produce accurate chart records of maximum legibility and continuously record up to a full year without refilling reservoir.

Easily installed as original or replacement equipment in all standard recording instruments. Available in five sizes and angles—special pens upon request.

- **Ends Unrecorded Intervals.** Unaffected by pulsating flows, chart speeds, rapid pen movement.
- **Sealed Ink Supply.** Prevents clogging from atmospheric contamination.
- **Two-Way Ink Flow.** Stainless steel writing point is positioned above ink level in reservoir and ink flows in either direction by capillary action—eliminates smearing, blurring.
- **Special Pens.** Designed and produced to customer specifications where special inking problems make standard pens impractical.

Write today for information

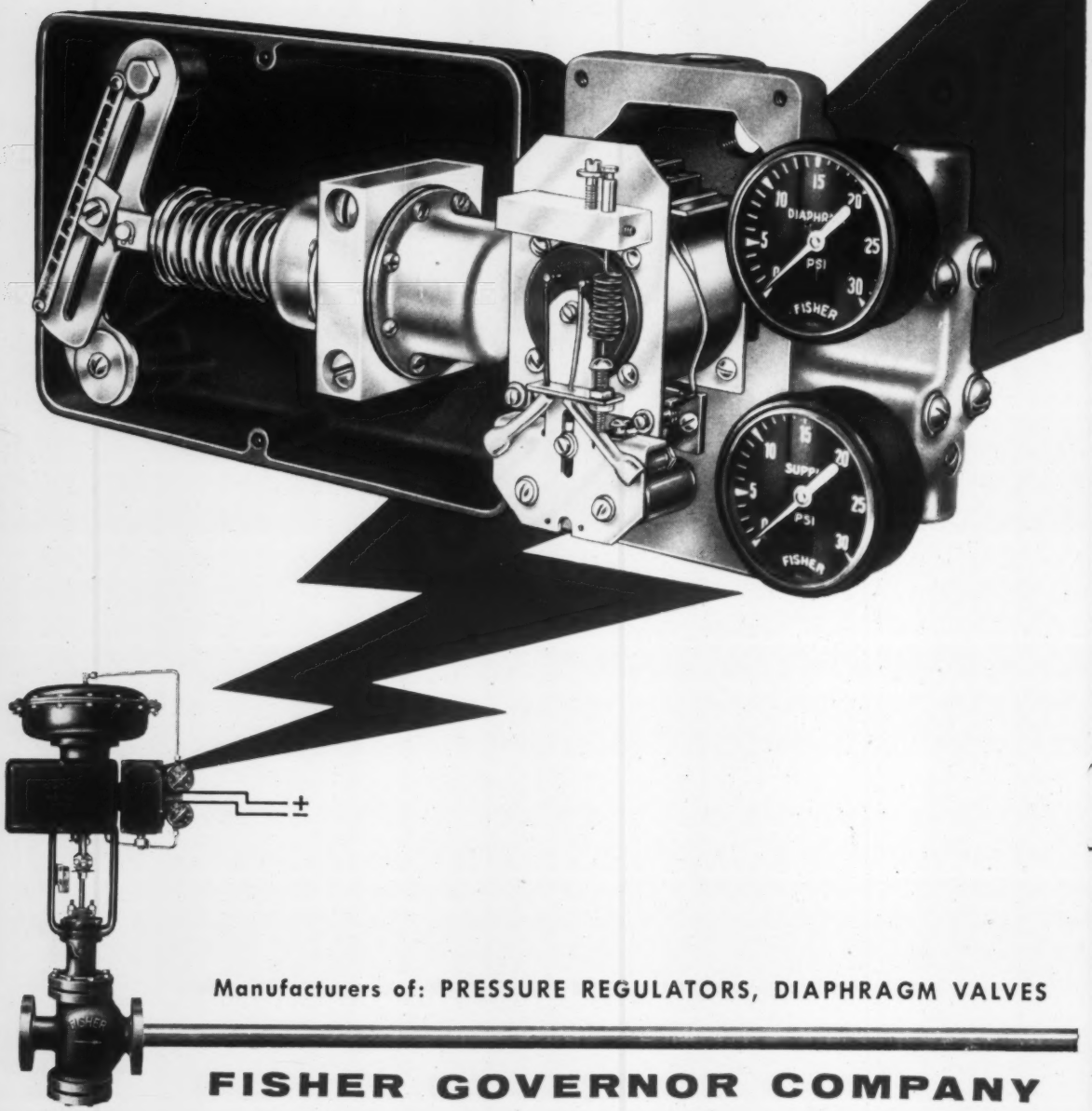
AMERICAN METER COMPANY
INCORPORATED ESTABLISHED 1836

GENERAL SALES OFFICE: Philadelphia 16, Penna. • Albany Alhambra • Atlanta • Baltimore • Birmingham • Boston • Chicago Dallas • Denver • Erie • Houston • Kansas City • Los Angeles • Minneapolis • New York • Omaha • Pittsburgh • San Francisco • Seattle Tulsa • Wynnewood. IN CANADA: Canadian Meter Company, Ltd., Milton Ontario • Calgary • Edmonton • Regina

SUPPLIERS TO THE GAS INDUSTRY for Ironcase, Tinned Steelcase, Aluminumcase and Welded Steelcase Meters • American-Westcott Orifice Meters Instruments • Reliance Regulators • Apparatus • Valves

For more information circle **15** on inquiry card.

Announcing the....



Manufacturers of: PRESSURE REGULATORS, DIAPHRAGM VALVES

FISHER GOVERNOR COMPANY

For more information circle **16** on inquiry card.

. . . a fast, sensitive electro-pneumatic valve positioner for dependable, accurate valve control

The FISHER E-POSITROL combines the advantages of fast transmissions from electronic controllers with the economy and dependability of pneumatically operated control valves.

The Type 3541 E-POSITROL consists of two units, First: The Type 541 Transducer, which produces a pneumatic out-put pressure that is proportional to a DC electrical in-put signal, Second: A pneumatic valve positioner (Type 3500) which accurately positions the valve stem as dictated by the pneumatic out-put pressure of the transducer.

A most important feature is that any FISHER Type 3500 Positrol valve positioner now in service can easily be converted to an electro pneumatic positioner by adding the transducer portion.

The transducer is attached to the side of a standard "Positrol" case and is available with different coils capable of utilizing a signal from any electronic instrument within the DC signal range of from .3 ma to 50 ma.

The transducer case is of explosion proof design. The FISHER E-POSITROL can be mounted on direct or reverse acting top works. Tests prove that stability, repeatability and frequency of response on this unit are excellent.

For full details write for Bulletin E-3541.

and LIQUID LEVEL CONTROLS

FISHER® Controls

Marshalltown, Iowa/Woodstock, Ontario

Since 1880

For more information circle **16** on inquiry card.

EPLAB

PYRHELIOMETER
For the Measurement of SOLAR RADIATION

Eppley Pyrheliometers are used for solar radiation measurements at ninety-eight weather stations in the continental United States, Canada, Alaska, Greenland, Iceland, Caribbean Sea, and the Pacific Ocean. Sixty-two of these stations are under the direction of the United States Weather Bureau.

The Eppley Pyrheliometer was adopted as standard equipment by the Weather Bureau after considerable experimentation. It was found to be the best instrument so far tested by the Bureau.

Used in conjunction with a suitable recorder, the Eppley Pyrheliometer will provide an accurate and reliable record of total solar and sky radiation on a horizontal surface.

Bulletin No. 2 on Request

THE EPPLEY LABORATORY, INC.

Scientific Instruments

2 Sheffield Ave.
Newport, Rhode Island U. S. A.

For more information circle **17** on inquiry card.

News Bits

PEERLESS ELECTRIC CO., Electronics Div. has developed an automatic control unit using an IBM card to batch ready-mix concrete.

A new process, imparting a better and more permanent coat of 24-carat gold to many metals, was disclosed by **BAKER & CO.**, one of the Engelhard Industries. Requiring no special equipment, objects are simply immersed in a bath, the tank of which will resist slightly acid or alkaline solutions.

BECKMAN INSTRUMENTS has received a contract to build electronic data system for Aluminum Co. of Canada.

JOHN CHATILLON & SONS has designed and built a running torque tester and dynamometer which runs fractional-hp motors through a complete cycle of tests. It was designed for a large manufacturer of motors who requires that the testing cycle be completely automatic except for loading and unloading the motors.

CUBIC CORP. announces new technique to dynamically measure electrical characteristics of transistors. Up to 200 transistors can be tested per hour.

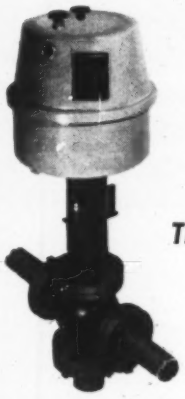
BELL LABS. has developed new technique of attaching leads to semiconductors, called thermo-compression bonding.

LINDE CO., Div. of Union Carbide has grown a clear sapphire disc 5″ in dia.

GENERAL ELECTRIC announces completion of the first of 18 rectifier cubicles slated for the Diamond Alkali Co.'s Deer Park plant, Houston, Tex. The 18 rectifier cubicles will comprise the largest germanium rectifier installation. 140,000 amps of direct current for the production of chlorine will be provided. When the installation is completed late this year it will be rated at 35,000 kw.

Askania Regulator Company NEWS

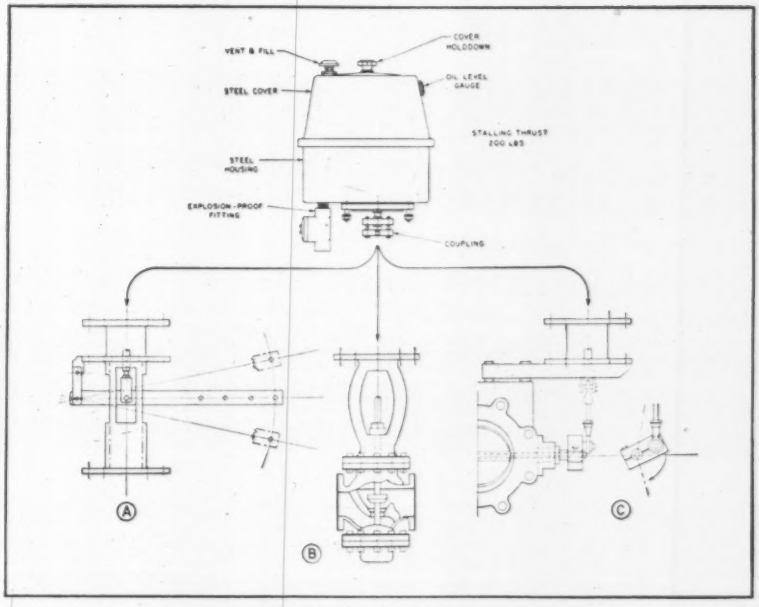
Automatic Controls for
PRESSURE, FLOW and COMBUSTION



As demonstrated at the ISA show

A NEW ASKANIA FINAL CONTROL ELEMENT

The Model RF-697 Electrohydraulic Valve Actuator



For Valves Requiring Less Than 200 lbs. Thrust

The Askania Model RF-697 Electrohydraulic Valve Actuator comprises a self-contained unit designed for proportional-position control, using signals from an electronic controller, manual station or directly from a measuring element.

Smaller, more compact and designed for operating valves with ½ to 1½ inch stroke requiring less than 200 lb. thrust, it operates from low level a-c or d-c signals. The d-c range is 1-5 or 4-8 milliamperes. For operation on a-c signals internal rectifiers are provided.

Design Provides Outstanding Operating Advantages

Exclusive design assures *stability*, *fast response*, and *dependable operation* marked by an ABSOLUTE MINIMUM OF MAINTENANCE. Note these important operating advantages:

1. Entirely self-contained
2. Operates directly from controller without relays or converters
3. Mechanically simple
4. Easy to mount on valve—simple to install
5. Competitively priced
6. Designed to meet Underwriters' Laboratories' explosion-proof requirements for Class I, Group D, Division 1 service.

Wide Valve Mounting Adaptability

The Model RF-697 Valve Actuator can be mounted on practically any valve. Typical valve mountings are shown at the right, above:

A. Mounted to provide a lever arm
B. Mounting for sliding-stem valve
C. Mounted on butterfly valve

Important Specifications

Valve Stem Speed...5 inches per minute at 150 lb. load
Valve Stem Stalling Thrust...200 lbs.
Valve Stem Stroke...½" to 1½"
Input Coil Resistance...Standard coil resistance approximately 12,000 ohms at operating temperature.

Send for Application Bulletin No. 38.3 for complete information on this new Electrohydraulic Valve Actuator. Write Askania Regulator Company, 268 E. Ontario Street, Chicago, Illinois.

ASKANIA REGULATOR COMPANY
"CONTROLS FOR INDUSTRY"
HYDRAULIC, ELECTRONIC CONTROLS & SERVOS, GENERAL SYSTEMS, ENGINEERING & COMPUTER SERVICE, VALVE ACTUATORS & CYLINDERS

A SUBSIDIARY OF
GENERAL PRECISION EQUIPMENT CORPORATION

GPE

For more information circle **18** on inquiry card.

The man who KNOWS— Knows where to LOOK—

And a more complete personal or company library assures easy accessibility to reference sources which can enhance your knowledge. Each of the books listed below is a "must" for the instrumentation library.

100 Electronic Circuits

by M. H. Aronson and C. F. Kezer . . . . covers amplifiers, oscillators, pulse circuits, phototube circuits, phase shifters, etc. Complete with all circuit component values and response specifications.

paper, 180 pages, illustrated .....Price **$2.00**

The Automatic Factory

by June, Bardis, Lurio, Polaner, Sagedahl, Sklenar and Yenken. Here is THE book for all who want FACTS rather than wild opinions . . . a fresh viewpoint on what "manless factories" CAN be — a book free from the generalities, platitudes, exaggerations and misconceptions repeated by many writers on this subject. 1955.

cloth, 88 pages, illustrated .....Price **$1.50**

Process Control

by A. J. Young, Head of the Central Instrument Laboratory, Imperial Chemical Industries, Ltd.

". . . a MUST for all men who have to do with the automatic control of industrial processes; combines the practical "how" and the theoretical "why." 1955.

cloth, 134 pages, illustrated .....Price **$2.00**

Heat Inertia Problems of Automatic Control of Temperature

by Victor Broida, based on the concept of "fictitious mass" of heating process unit under automatic control. 1950.

paper, 5¼" x 8¼", 61 pages .....Price **$1.00**

Applications of Industrial pH Controls

by Allen L. Chaplin, 1950.

cloth, 4½" x 8", 144 pages .....Price **$2.00**

Operation and Care of Circular-Scale Instruments

by James Spencer, profusely illustrated with circuit diagrams, schematic diagrams, and photographs. 1949.

cloth, 4½" x 8", 90 pages .....Price **$1.50**

Process Control Analysis

by Millard H. LaJoy and E. Allen Baillif. ". . . an essential first step in analysis of closed-loop controlled processes via frequency response of the system." 1956.

cloth, 72 pages, illustrated .....Price **$2.00**

Instruments Publishing Co.

845 Ridge Ave.. Pittsburgh 12. Pa.

For more information circle **19** on inquiry card.

NEWS —CONTINUED

FISCHER & PORTER has purchased an electronic differential analyzer from **ELECTRONIC ASSOCIATES,** to be used for studying dynamic control system performance, and for analysis of operating characteristics of industrial instruments and instrument components under development.

MINNEAPOLIS-HONEYWELL has begun full-scale production of epoxy casting and potting compounds designed for use in the electronics industry. Originally intended to satisfy the precise encapsulating requirements of its Aeronautical Div. the company feels its unique compounds will find wide application among other electronics companies.

GENERAL ELECTRIC'S Communication Products Dept. has installed a two-way radio system for New Orleans' city employees concerned with swift removal of surface water caused by torrential rains. All pumping stations are radio-equipped, therefore all stations know the situation at all other stations, in a completely integrated system.

MINE SAFETY APPLIANCES has developed a new respirator which is in use at the Domaniale Coal Mine, Kerkrade, Netherlands, with excellent results. Called "Dustfoe" the respirator has proved efficient in combating silicosis. Total weight is 4½ ounces.

Stock Report

Any further information concerning any of the following issues may be obtained from the Research Department, Bache & Co., 36 Wall Street, New York 5, N. Y.

New York Stock Exchange:

	Price Range For 1957 Thru August 14th		Price As Of August 14th
	High	Low	
ACF Industries	64 7/8	58 1/8	60
Aeroquip Corp.	31 3/8	20 1/8	26 1/4
Allis Chalmers	36 1/4	32	33 3/8
American Chain & Cable	64 1/4	46 3/4	53 1/2
American Machine & Foundry	43 3/4	31 5/8	39
American Machine & Metals	58 3/4	41	53 1/2
American Optical	37 7/8	33	34 3/4
American Tel. & Tel.	179 7/8	170 1/2	172 1/8
Beckman Instruments	47 3/4	35 1/4	37 1/4
Bell & Howell	50 1/2	36 1/2	45 1/2
Bendix Aviation	66 3/4	52 5/8	58 7/8
Boeing Airplane	61 1/8	37 3/8	46 7/8
Bullard	29 1/8	17 5/8	17 3/4
Bulova Watch	21	16 5/8	16 3/4 - 17 (1)
Burroughs	52 3/8	33 7/8	42 3/8
Carborundum	51 1/4	36 3/4	42 5/8
Cincinnati Milling Machine	50 1/2	33 7/8	38 3/4
Clevite	25 1/2	18	22 1/4
Columbia Broadcasting 'A'	36 1/8	29 3/4	30 1/4
Consolidated Electronics	35 1/2	26 1/4	29 3/4
Cornell Dubilier	27 1/2	19 1/4	20
Corning Glass	106 1/4	57 1/4	85 1/2
Curtiss-Wright	47 3/8	38 3/4	39
Cutler Hammer	64 3/4	51 1/2	53 1/2
Consolidated Electrodynamics	54 3/4	31 1/4	40 1/2
Davstrom	47	29 5/8	42 1/4
Dobeckman	49	24 1/4	42 5/8
Douglas Aircraft	91	66 1/2	65 1/4
Eastman Kodak	115	82 3/4	100 1/4
Eaton Manufacturing	64 1/4	43	55
Electric Auto Lite	40 3/8	30 1/4	37 1/4
Elgin Watch	14 1/8	10 5/8	10 5/8
Emerson Electric	34	27 5/8	28 1/8
Food Machinery & Chemical	65 1/4	53	56
Gamewell	36 1/2	28	28
Garrett	54	36 1/4	36 1/4
General Dynamics	68 5/8	54 1/8	54 5/8
General Electric	72 3/8	52 3/8	65 3/4
General Instrument	6 1/8	6 1/4	6 1/4
General Mills	69	57 7/8	58 1/4
General Precision Equipment	47 1/4	36 1/2	42 5/8
General Railway Signal	34	27	30 1/4
General Telephone	45 1/4	34 1/2	40 3/8
General Time	30 1/2	21 3/4	(1) 21 1/2 - 21 3/4
General Tire & Rubber	98 1/2	55 1/4	84 3/4
International Business Machines	376 1/2	266	310 1/4
International Tel. & Tel.	37 3/4	24 1/2	31 1/2
Lockheed Aircraft	57 1/8	36 1/8	45 3/8
Litton Industries	56 5/8	29 1/2	46 1/2

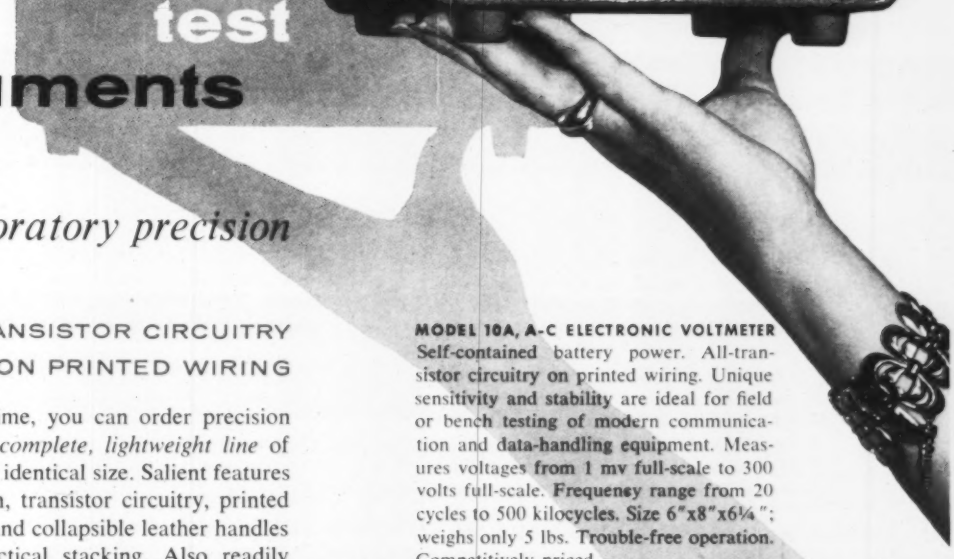
Continued on page 1650

CEC announces the new

ALECTRA *line . . .*

portable test instruments

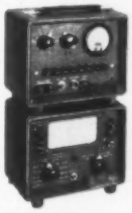
. . . with laboratory precision



ALL-TRANSISTOR CIRCUITRY ON PRINTED WIRING

Now, for the first time, you can order precision instruments from a *complete, lightweight line* of miniaturized units of identical size. Salient features are battery operation, transistor circuitry, printed wiring. Rubber feet and collapsible leather handles guarantee easy, practical stacking. Also readily adaptable to standard rack mounting, these units assure instant stable operation with no warm-up time. *Contact your CEC field office, or write* today for Bulletin CEC 7000-X9.

MODEL 10A, A-C ELECTRONIC VOLTMETER
Self-contained battery power. All-transistor circuitry on printed wiring. Unique sensitivity and stability are ideal for field or bench testing of modern communication and data-handling equipment. Measures voltages from 1 mv full-scale to 300 volts full-scale. Frequency range from 20 cycles to 500 kilocycles. Size 6″x8″x6¼″; weighs only 5 lbs. Trouble-free operation. Competitively priced.



MODEL 25A
TEST OSCILLATOR (TELECOMMUNICATIONS)
8 preset frequencies (pushbutton)
Balanced output—600 ohms impedance

MODEL 15A
MULTI-RANGE A-C VOLTMETER
Balanced input—30 cps to 300 kc
1 mv to 300 v full-scale

MODEL 14A, TRUE-RMS A-C VOLTMETER
0.5 mv full-scale
Response: 10 cps to 500 kc

MODEL 20A
TEST OSCILLATOR
15 cps to 150 kc
0.5-ohm output impedance

MODEL 21A
TEST OSCILLATOR (PUSHBUTTON)
8 preset frequencies
15 cps to 150 kc

MODEL 11A, DBM/DBA METER
For bridging 600-ohm circuits
Balanced input—50 cps to 25 kc

MODEL 40 SERIES
CARRIER FREQUENCY ATTENUATORS
0.2 db accuracy, d-c to 600 kc
1-db steps to 82 db

Consolidated Electrodynamics

ALECTRA DIVISION (CEC) *325 North Altadena Drive, Pasadena 15, California*

OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

For more information circle **20** on inquiry card.

because . . .
our business is the
design and manufacture of
temperature measuring
instruments . . .
and has been since 1867.

Close to 90 years
of experience in this field
has made the name of
MOELLER the standard of
accuracy and reliability.

For information on these
precision products
made by Moeller
mail the coupon, today.

MOELLER INSTRUMENT COMPANY
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Representatives in Principal Cities

Gentlemen: Without obligation, please send me Moeller Catalog No. 150 on Thermo-Wells, Separable Sockets, Thermo-Couple Protecting Wells and Tubes.

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CITY ..... ZONE ..... STATE .....

For more information circle **21** on inquiry card.

NEWS—CONTINUED

New York Stock Exchange:

Continued from page 1648

Magnavox	44	35	36 1/8
Minneapolis-Honeywell	131	73 1/2	99 1/4
Minnesota Mining & Mfg.	101	56	86 1/2
Motorola	51 3/4	35 3/4	46
Mallory, P.R.	50 1/4	40 5/8	39 1/2
National Acme	80 1/2	53 1/2	57
National Cash Register	70 5/8	46 1/4	51
North American Aviation	39 1/4	24	24
Northrop Aircraft	28 1/8	23 1/2	22 3/8
Otis Elevator	49 1/2	34 1/8	47 7/8
Philco	18 3/8	14 1/8	15 1/4
Radio Corp. of America	40	31 5/8	34
Raytheon	23 3/4	16 3/8	23
Rheem Manufacturing	21 1/4	16 1/2	16 1/2
Robertshaw Fulton	36 1/2	25 5/8	32 1/8
Reliance Electric	50 7/8	36	42 1/4
Saxgamo Electric	39 3/4	31 1/4	37 1/4
Sperry Rand	26 1/8	20	22 3/4
Square D	35 3/4	28 1/8	30 1/2
Standard Coil Products	9 3/8	6 1/2	7 1/8
Starrett (L.S.)	85 1/2	62 1/2	70 1/2 - 74 (2)
Stewart-Warner	41 5/8	31 7/8	36 3/4
Sylvania Electric	46 1/4	36 1/4	35 1/2
TelAutograph	8 3/4	5	5 7/8
Texas Instruments	31 1/2	15 7/8	25 5/8
Thompson Products	89 3/4	67 1/2	67 1/2
Tung-Sol Electric	37 1/2	27 3/8	30 1/8
Underwood Corp.	33 3/4	23 3/4	24 3/4
Union Carbide & Carbon	124 1/2	100 5/8	113
Western Union	20 3/8	17 7/8	18
Westinghouse Air Brake	33 1/8	26 1/2	27 1/2
Westinghouse Electric	68 5/8	52 5/8	62 3/8
Worthington Corp.	68 1/8	52 1/4	57 3/4

(1) Not Traded - Bid-Asked
(2) Not Traded - Bid-Asked

American Stock Exchange:

	Price Range For 1957 Thru August 14th		
	High	Low	Price As Of August 14th
American Meter	34 1/8	30 1/2	31
Arc Equipment	22 7/8	17 1/2	18 3/4
Belock Instrument	13 5/8	9	11
Benrus Watch	8 1/2	6 7/8	7 1/4
Breeze Corp.	8 3/8	5 3/4	6 7/8
Barry Controls	12 3/4	10	10
Clark Controller	31	22	23 - 24 (1)
Clarostat Mfg.	5	3 3/8	4 3/8
Clary Corp.	4 7/8	4 1/4	4 1/2
DuMont Laboratories	6 1/8	4 5/8	4 5/8
Dynamics Corp. of America	7 5/8	5 3/8	5 1/4
Electronics Corp. of America	12 7/8	8	9 1/8
El-Tronics	3 7/8	2 1/8	2 5/8
Fairchild Camera & Instrument	27 3/8	16	23 1/4
Globe-Union	20 3/4	16 5/8	19 - 19 1/2 (2)
Hazeltine Corp.	44 1/2	30 1/2	35 3/8
International Resistance	6 1/8	4 3/4	4 7/8
Lear, Inc.	8 3/4	5 3/4	5 1/8
National Research	26 5/8	17 1/2	19 5/8
Neptune Meter	33 1/2	27 1/4	31 1/4
New Haven Clock	9/16	1/4	1/4
Norden-Ketay	11 3/4	7 7/8	9
Nuclear Corp. of America 'A'	2 1/4	3/4	1 7/8
Pneumatic Scale	25	23	23 - 24 1/4 (3)
Servo Corp. of America	8	4 5/8	6 3/4
Servomechanisms	12 5/8	9 1/2	9 7/8
United Shoe Machinery	45 7/8	39 1/2	39 5/8
Wallace & Tiernan	33 7/8	25 7/8	31 1/2
Waltham Watch	2 1/4	1 1/2	1 5/8

(1) Not Traded - Bid - Asked
(2)
(3)

Over-The-Counter

	Quotation As Of August 14th	
	Bid	Asked
Aerovox Corp.	5 3/8	6 1/2
Aircraft Radio Corp.	21 1/4	22 3/4
Argus Corp.	19 3/8	20 1/8
Eitel-McCullough Co.	33	34 1/2
Electronics Associates	48	50
Elox Corp. of Michigan 'A'	8 1/2	10 1/4
Elox Corp. of Michigan 'B	9 1/2	10 1/4
Erie Resistor Corp.	10 7/8	11 3/4
G.M.Giannini	16	17
Liquidometer Corp.	7	7 5/8
W. L. Maxson	6 3/4	7 3/8
Penn Controls, Inc.	16 1/2	17 1/2
Speer Carbon, Inc.	32	33 1/4
Sprague Electric	32 1/2	34
Taylor Instrument	82	84 1/2
Telecomputing Corp.	4 3/8	4 3/4
Topp Industries	13 5/8	14 3/8
Varian Associates	19 1/2	20 1/8
Vitro Corp. of America	25 1/4	26

Why **DYNALOG*** *design is out front of all electronic potentiometers . . .*

IT GIVES STEPLESS, CONTINUOUS BALANCING!

Advance features to improve control of temperature, pressure, flow . . .

1. No periodic maintenance
2. No dry cell—no standardizing
3. No high-speed moving parts
4. No slidewire or galvanometer
5. *Stepless*, continuous balancing
6. Adaptable to narrow spans

FOXBORO
REG. U.S. PAT. OFF.
DYNALOG
ELECTRONIC INSTRUMENTS

Here's precision in motion . . . the smooth, continuous balancing action of a Dynalog Electronic Instrument! No slidewire with faltering step-by-step inaccuracies . . . no sliding or rubbing contacts. Instead, a simple, variable, radio-type capacitor and positive magnetic drive. It's friction-free, wear-free.

That's why Dynalogs respond almost instantly to the slightest change in a process variable, with a sensitivity of 1/100 of 1% of scale . . . accuracy of ¼ of 1% of scale. It's also the reason they're the maintenance man's dream. About all he does is supply ink and charts!

Dynalogs are used with any primary element—resistance, voltage, capacity, inductive. They perform with effortless accuracy, even on control and recording problems that conventional balancing-type instruments can't handle. For the complete story, write for Bulletin 20-10. **The Foxboro Company, 469 Neponset Ave., Foxboro, Mass., U.S.A.**

*Reg. U. S. Pat. Off.

For more information circle **22** on inquiry card.

NOW! A REVOLUTIONARY NEW CONCEPT IN PRECISION DIGITAL MEASUREMENTS OF AC, DC, Ohms and RATIOS

New E-I transistorized plug-in modules give maximum flexibility for custom applications with standard off-the-shelf modules.

This latest E-I development provides the maximum versatility in digital instrumentation. From a few basic modules a host of instruments can be constructed. Basic modules never become obsolete. To do new jobs, simply add new modules. Equipment can be easily kept current at minimum cost and engineering.

But versatility is only part of the story. These new modules also boast dramatically new engineering specifications, fully transistorized circuits and numerous other features which were incorporated as the result of our experience with more than 1,000 digital instruments in the field.

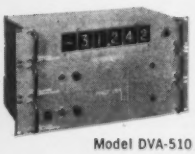
Your E-I representative has complete information on this latest E-I development. Ask him about it... today!

Any precision instrument for measuring DC, AC-DC, Ohms, DC and AC ratios can be constructed from these five basic units!

Model DVA-500

whether it be a DC digital voltmeter...

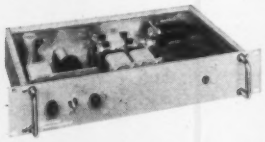
an AC-DC digital voltmeter...



Model DVA-510

or a complete check-out system.

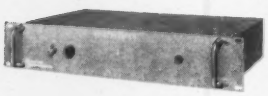
BASIC MODULES



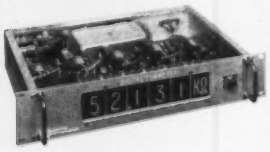
Universal Power Module
Supplies all power and reference voltages for other E-I modules. Power and reference supplies and stepper drive amplifier are transistorized. Powers one or more modules. Automatic calibration; stability of 0.01% from 40° to 125° F.; input power: 115 volts, 50 to 400 cycles.

DC Switch Modules, 4 or 5 digits
Visual in-line read-out of digits, polarity, decimal point. All contacts accessible at rear panel connector. Front and rear panel input connectors. Power supplied by Universal Power Module.

DC Pre-Amp Module
Input: 1 range scale, gain of 10.
Output: 0.001 to .9999 volts.
Linearity: 0.01%.
Gain Multiplication Accuracy: 0.01%.
Input Power: 115 volt, 50 to 400 cycles.
Drift: 10 microvolts per hour.



AC – DC Converter Module
A fully transistorized AC – DC converter.
Accuracy: 0.1% of reading, or 2 mv.
Frequency Response: 30 to 10,000 cycles.
Range: .0001 to 999.9 volts.
Zin, AC: 1 meg. on the 1 volt scale, 10 megs. on other scales; 20 mmf.
Ranging: Automatic
Reading Time: 3 seconds, average.



Resistance Switch Modules, 4 or 5 digits
Contains balance circuit, bridge ratio arms. Provides visual in-line read-out digits, range. All contacts accessible at rear panel connector. Power supplied by Universal Power Module.

New short form catalog now available. Write for yours today!

ELECTRO INSTRUMENTS INC.

3794 ROSECRANS, SAN DIEGO, CALIFORNIA

For more information circle **23** on inquiry card.

New Plants and Mergers

BROOKS ROTAMETER announces move to new 27,000 sq-ft plant at Hatfield, Penna.

STACKPOLE CARBON has erected a new plant at Kane Pa.

MIDWESTERN INSTRUMENTS announces its Magnecord Div. has moved to Tulsa.

SERVOMECHANISMS INC. has bought the assets of Precision Components Inc. after recently acquiring Silver Plastics Corp.

S. MORGAN SMITH has moved valve operations to York, Penna.

POTTER INSTRUMENT CO. has opened a new factory and office building of 50,000 sq ft.

AUDIO DEVICES INC. is expanding its plant for 500% increase in production of magnetic computer tape.

FISHER GOVERNOR announces agreement to exchange common stock for assets of Continental Equipment Corp.

BENDIX AVIATION announces a 100% expansion of its Computer Div. plant.

NORDEN-KETAY has concluded a licensing agreement with Societié Anonyme Precilec, for manufacture and sale of its products in France.

The AUTOMATIC ELECTRIC group has moved to new 1,520,000 sq-ft facilities at Northlake, Ill.

MINIATURE PRECISION BEARINGS, INC. announces merger with **SPLIT BALLBEARING CORP.**

AMERICAN MACHINE and METALS, parent company of U. S. Gauge, announces purchase of Hunter Spring Co. which is to be operated as a wholly owned subsidiary.

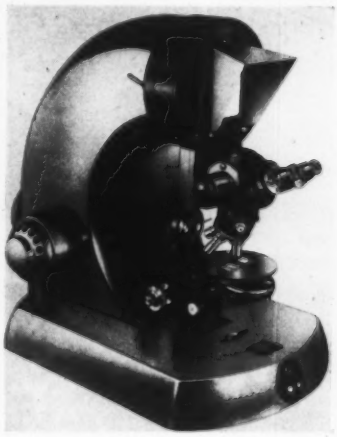
AUTOMATIC TIMING & CONTROLS INC., (new name of Automatic Temperature Control Co.) announces move to new plant in King of Prussia, Penna.

The **NEW** Camera Microscope

ULTRAPHOT II

CARL ZEISS

WEST GERMANY



Microscope, camera and exposure meter combined in one instrument. Completely automatic shutter is activated by a photoelectric cell computing exact exposure times and insuring correctly-exposed photomicrographs under even the most adverse conditions.

Three different light sources, including an electrically-controlled arc lamp, are available for instant use. By utilizing the Koehler principle specimens can be observed and photographed in bright field, dark field and phase contrast, as well as with incident light.

A built-in movable mirror system simulates bellows extension up to 12 inches and permits gradual magnification (6.5x to 1700x) change. A 4x5-inch Graflok back allows also the use of available smaller sheet film adapters.

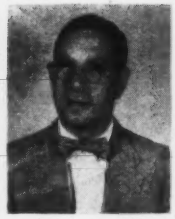
The revolutionary design of the ULTRAPHOT II is years ahead of existing equipment!

Write for literature

CARL ZEISS, INC., 485 Fifth Avenue, New York 17, N. Y.

Guaranteed uninterrupted repair service

People IN THE NEWS



George Keller
Brooks

C. J. Munter
Hagan

Harold Wiley
C-E-C

Dr. Arthur Ruge
B-L-H

BROOKS ROTAMETER CO. announces appointment of *George D. Keller* as chief engineer.

HAGAN CHEMICALS & CONTROLS INC. has appointed *C. J. Munter* nuclear energy consultant.

CONSOLIDATED ELECTRODYNAMICS CORP. announces the appointment of Robert D. Ridgway as manager, sales operations, and *Harold F. Wiley* as director of its newly established Analytical and Control Instrument Div.

BALDWIN-LIMA-HAMILTON CORP. has appointed *Dr. Arthur C. Ruge* director, research development, and *Robert P. Lathrop* manager, research and development.

COHU ELECTRONICS INC. has named *John P. Day* chief development engineer, Kin Tel Div.

ASSEMBLY PRODUCTS INC. has appointed *Frank L. Ross* manager, quality control.

POTTER & BRUMFIELD announces the appointment of *Nelson Havill* as general sales manager.

LEEDS & NORTHRUP announces promotions of *Dr. William G. Amey* to manager, research div.; *Robert H. Cherry* to manager, development div.; *George E. Beggs*, asst. to president, long range planning; *R. Dean Eanes*, head, analysis instrumentation; *Victor S. Underkoffler*, head, nucleonics; *Dr. Edgar L. Eckfeld*, head, chemical section, research; *Will McAdam*, head, electrical section.

BRUSH ELECTRONICS CO. has named *Ralph V. Little* manager of the Product Engineering Dept., and *Reginald G. Schuler* general engineering manager.

CLIFTON PRECISION PRODUCTS has elected *Louis E. Fagan* senior vice president; *Arnold E. Hayes*, V. P. & G. M.; *Thomas W. Shoop*, V. P. Sales.

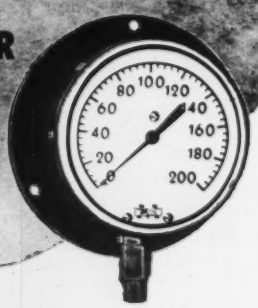
EPSCO announces appointment of *William J. Peet II* as advertising and promotion manager.

BJ ELECTRONICS has named *Edward H. Rehnborg* chief, Transducer Products.

BECKMAN INSTRUMENTS INC. has selected *Robert M. Ward* as manager, Berkeley Div.

MARSHALLTOWN

THE RIGHT GAUGE FOR YOUR SPECIFIC NEEDS



- PRESSURE
- VACUUM
- COMPOUND
- ALTITUDE
- COMBINATION
- DIAPHRAGM
- HYDRAULIC
- AND SPECIAL PURPOSE GAUGES
- DIAL THERMOMETERS (Vapor Tension or Bi-Metal)

• Available in a wide variety of general purpose and special purpose gauges in pressure ranges to meet your specifications in every particular.

WRITE TODAY FOR COMPLETE INFORMATION

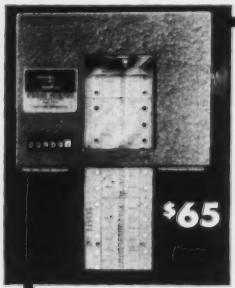
MARSHALLTOWN MANUFACTURING CO.

800 EAST NEVADA ST.
Marshalltown 3, Iowa

For more information circle **25** on inquiry card.

TIME RECORDER + TOTALIZER

automatic, continuous, operating data can be the difference between Profit and Loss!



Modern plant operation demands the most efficient and accurate means of evaluating both machine and man-power production . . . that's why leading companies everywhere are equipping their production lines, processes, systems and office machines with Time Recorder-Totalizers.

The Time Recorder-Totalizer monitors the operation of any machine, process or system by chronologically recording the time and duration of every "on" and "off" period during each day.

The Time Recorder-Totalizer makes it possible to analyze the efficiency and performance of any type of equipment plus simplifying cost accounting.

The TIME RECORDER-TOTALIZER incorporates the following features:

SPROCKET DRIVEN CHART . . . accurately timed . . . chronologically printed . . . available in speeds from one inch per hour to ten inches per minute . . . 250 linear feet per roll . . . each $1.25.

ELAPSED TIME METER . . . (Time Totalizer) registers accumulated "on" or production time.

AUTOMATIC REWIND ATTACHMENT with housing . . . facilitates inspection of strip chart during any period throughout the entire roll. (available for all models . . . $7.50 extra)

RUGGED CONSTRUCTION assures long carefree operation.

For complete information write to: Dept. IA-R1-9

standard INSTRUMENT CORPORATION
DIVISION OF HEAT-TIMER CORPORATION

657 BROADWAY. NEW YORK 12, N. Y.

Mfrs. of: Heat-Timer Electronic Controls, Heat Recorder-Totalizer, Varivalve, Thermovalve, Main Line Quick-Vent Valve, Motorized Valves, Smoke-Eye Smoke Alarm, Fire-Chief Fire Alarm, H-T Burner Alarm.

VISIT BOOTH 855 AT ISA SHOW.

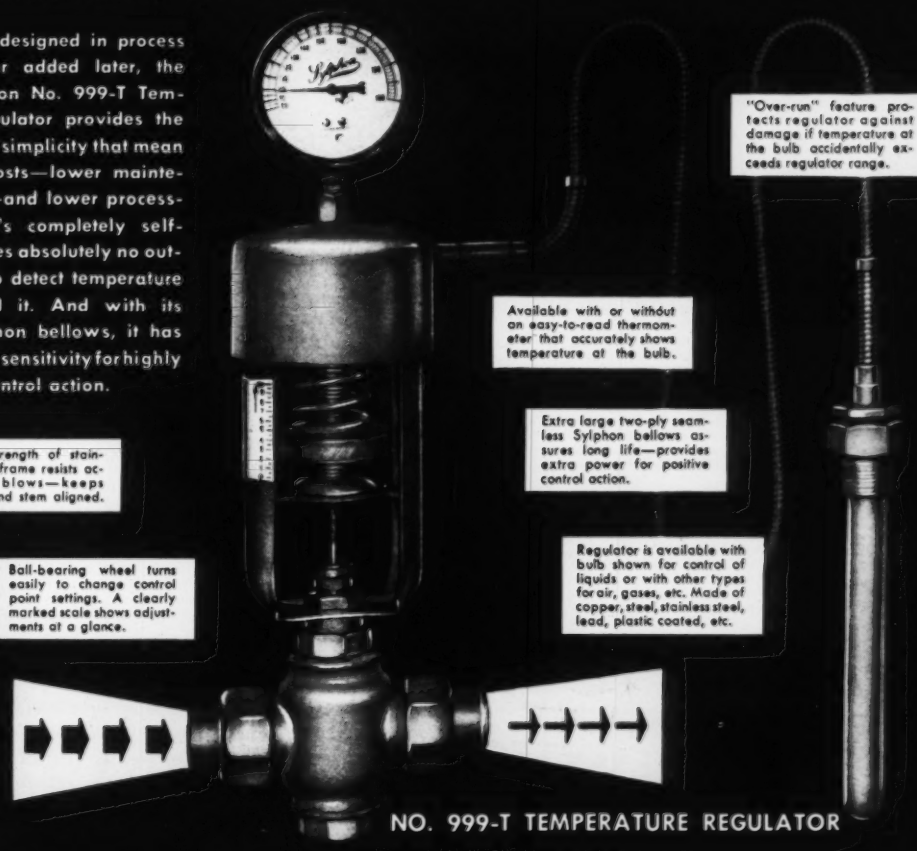
For more information circle **26** on inquiry card.

FULTON SYLPHON TEMPERATURE REGULATOR HEADQUARTERS, U.S.A.

CONTROLS TEMPERATURE
UNDER ITS OWN POWER

COMPLETE LINE OF REGULATORS, VALVES, MIXERS, AND CONTROLS FOR LIQUIDS, AIR OR GASES.

Whether it's designed in process equipment or added later, the Fulton Sylphon No. 999-T Temperature Regulator provides the accuracy and simplicity that mean lower first costs—lower maintenance costs—and lower processing costs. It's completely self-contained, uses absolutely no outside power to detect temperature or to control it. And with its famous Sylphon bellows, it has the power and sensitivity for highly responsive control action.



"Over-run" feature protects regulator against damage if temperature at the bulb accidentally exceeds regulator range.

Available with or without an easy-to-read thermometer that accurately shows temperature at the bulb.

Extra large two-ply seamless Sylphon bellows assures long life—provides extra power for positive control action.

Added strength of stainless steel frame resists accidental blows—keeps bellows and stem aligned.

Ball-bearing wheel turns easily to change control point settings. A clearly marked scale shows adjustments at a glance.

Regulator is available with bulb shown for control of liquids or with other types for air, gases, etc. Made of copper, steel, stainless steel, lead, plastic coated, etc.

NO. 999-T TEMPERATURE REGULATOR

Available with 60 F ranges between 20 and 455 F.
Variety of valve types in sizes from ¼" to 4".

Mr. Controls

Robertshaw-Fulton CONTROLS COMPANY

FULTON SYLPHON DIVISION
Knoxville 1, Tenn.

Robertshaw-Fulton Controls Co.
FULTON SYLPHON DIVISION
Knoxville 1, Tenn.

☐ Send literature on Temperature Regulators for Industrial Processes, Catalog D-RL

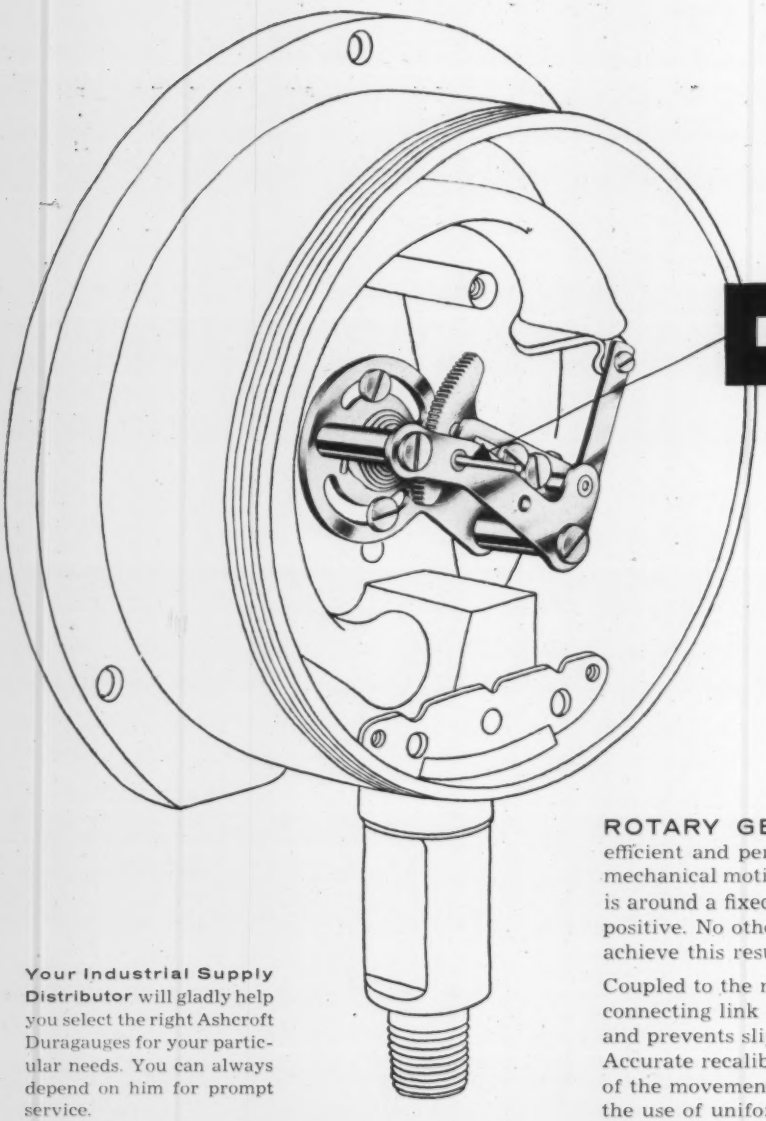
Name_____

Company_____

Address_____

City_____ State_____

For more information circle **27** on inquiry card.



Why does the MOVEMENT in the ASHCROFT DURAGAUGE outperform all other types?

ROTARY GEARED MOTION, the most efficient and perfect method of transmitting mechanical motion ever developed. Because rotation is around a fixed center, pointer position is always positive. No other type of movement can ever achieve this result.

Coupled to the movement is a one-piece connecting link that guarantees correct calibration and prevents slippage or parting under tension. Accurate recalibration is easy from front or rear of the movement. Universal adjustability permits the use of uniformly graduated dials, thereby facilitating maintenance.

The Ashcroft Duragauge is available with all-stainless-steel movement or stainless steel with nylon bearings and pinion gear. There are case designs and materials, Bourdon tube materials, pressure ranges and dial sizes to meet your service conditions exactly. Save time, trouble and money. Specify the pressure gauges of highest sustained accuracy and durability – Ashcroft Duragauges.

Your Industrial Supply Distributor will gladly help you select the right Ashcroft Duragauges for your particular needs. You can always depend on him for prompt service.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

ASHCROFT GAUGES

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

For more information circle **28** on inquiry card.

How to cope with an avalanche of urgent data

Tape keeps ballistic missile tests in manageable form

Four of the twenty-four Ampex FR-100 Tape Transports at the General Electric Missile and Ordnance Systems Department facility in Philadelphia.

Nobody intends to get buried, drowned, suffocated or trampled as the floodgates open on one of the biggest of all data-acquisition programs. For its ballistic missile development contracts, General Electric's Missile and Ordnance Systems Department has installed a data-processing and computation center to match the challenge.

A PREFERENCE FOR TAPE

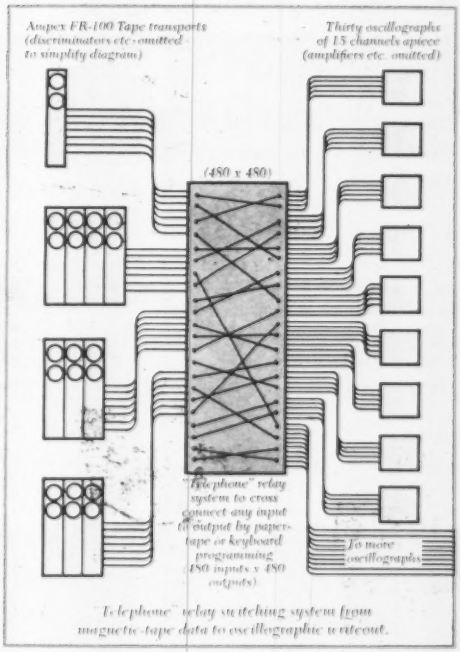
Of the test information received, about 90 percent will be on tape. Two facts about magnetic tape recording help keep the sheer mass of information under control: (1) hundreds of simultaneous parameters are recorded on one tape with a common time base; (2) tape gives live electrical voltages, hence reducing, correlating, computing and handling steps can be done automatically. General Electric's goal is to provide all interested engineering groups with both analog and computed data within three days of receipt of raw tapes.

Tapes from flight test, ground test and component development will be received from sources all over the U.S. These tapes will include quarter, half and one-inch widths. Hence most "tape stations" in the data-reduction system will have three Ampex FR-100 tape transports for the three widths. They will share electronics.

NOVEL USE OF A TELEPHONE TECHNIQUE

The right data must get to each of a large number of research and design groups. No traffic snarls allowed – so General Electric's engineers have made ingenious use of taped data's electrical form. They use a "telephone central station." After the necessary conversion steps, hundreds of channels of data from magnetic tape are fed into an automatic relay switching system. This connects them into 450 channels of oscillographic writeout (30 oscillographs with 15 channels apiece). When desired one input can go through a multiple relay putting the same data trace on two or more of the oscillograph records. Programming is done by a carefully checked paper tape. The end result is visual traces in a desired side-by-side relation. And each oscillograph record contains the data of interest to particular engineering groups.

Magnetic tape comes to life again in computation. The visual records are marked wherever special computer effort is required. Another group


Ampex FR-100 Tape transports (discriminators etc. omitted to simplify diagram)
Thirty oscillographs of 15 channels apiece (amplifiers etc. omitted)
(480 x 480)
"Telephone" relay system to cross connect any input to output by paper-tape or keyboard programming (480 inputs x 480 outputs)
To more oscillographs

"Telephone" relay switching system from magnetic-tape data to oscillographic writeout.

of Ampex FR-100 Tape Reproducers plays the tapes through a high-speed analog-to-digital conversion system which finds and converts selected sections to digital form at a rate of 45,000 conversions per second.

If mass of data is your problem, we would be pleased to discuss some practical answers. Or would you like to have this informative ad series mailed direct? For either request, write Dept. BB7

MAGNETIC TAPE APPLICATIONS BY AMPEX

ONE OF A SERIES 7

Series FR-100

Series 800 Mobile and Airborne

Model FR-200 Digital

Series FL-100 Loop Recorders

Series FR-1100

INSTRUMENTATION DIVISION
AMPEX CORPORATION
FIRST IN MAGNETIC TAPE INSTRUMENTATION
934 CHARTER STREET · REDWOOD CITY, CALIFORNIA

District offices serving all areas of the United States and Canada; Foreign Representatives in countries around the world.

For more information circle **29** on inquiry card.

LEWIS

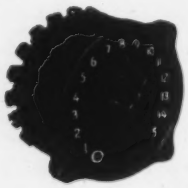
RESISTANCE THERMOMETER AND ACCESSORIES

The Model 62 RT4F Resistance Thermometer is a sturdy, easy to read instrument with a six inch hand drawn scale. It is suitable for use in moving vehicles, is excellent for flight testing or for permanent panel installations. Operated by an ordinary dry cell and calibrated to standard "AN" bulb curves, this instrument is ideal for use with any of the resistance bulbs illustrated below. Other ranges available in °C or °F.

ACCESSORIES — RESISTANCE BULBS AND SWITCHES

Lewis Selector Switches have been used for years in automotive test work as well as in permanent installations. Simple, sturdy construction plus finest materials combine to give long service.

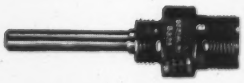
4" SIZE TO 28 POINTS



3" SIZE TO 20 POINTS

2" SIZE TO 4 POINTS

FREE AIR



THREADED "AN" TYPE

THREADED "AN" TYPE

BAYONET TYPE FOR CYLINDER HEAD TEMPERATURE

Lewis Resistance Bulbs are adaptable for use with the 62RT4F Resistance Thermometer or with standard aircraft panel indicators. Special purpose bulbs with stem variations or for high temperature applications are available.

We invite inquiries on your temperature measuring problems.

THE LEWIS ENGINEERING CO.

Manufacturers of *Complete* Temperature Measuring Systems for Aircraft

NAUGATUCK, CONNECTICUT

For more information circle **30** on inquiry card

INSTRUMENTS and AUTOMATION Trends

About 2000 infrared spectrometers are in use in U.S.A. today; another 1000 are expected to be sold in 1 or 2 years. New low-cost lines (about $4000) should expand market by at least 500 units a year. New lines were main feature of last Pittsburgh analytical show.

In 3 years the number of computing centers (analog and digital) in the world increased from 20 to 60, 50 of which are in the U. S.

FCC reports that in 10 years, radio authorizations (stations and operators) increased to 1,600,000 from 550,000; that classes of radio service increased to 65 from 40; nonbroadcast authorizations increased to 7000 from 2500.

1000 orders in few months since introduction of the random-access memory units RAMAC (Random Access Memory Accounting Machine—$3500/month) has caused IBM to revise market predictions upwards, radically.

By 1980, more than 50 new test reactors will be necessary to support the installation of more than 2,200 nuclear power plants in the U.S., predicts W. Kenneth Davis, Director of Reactor Development, U. S. Atomic Energy Commission, Washington, D. C.

Industrial closed-circuit TV market was $1 million in 1954, $2.1 million in 1955, $3.3 million in 1956.

Outstanding U. S. scientific accomplishments of 1956, as reported by C. G. Suits, Director of Research of GE, include: super-strong permanent magnets made from pure iron dust; infrared techniques for photographing crystal dislocations in semi-conductors; high-temperature radio components; and discovery of the anti-neutron.

Of $11.5 billion electronics market, about $6 billion is in equipment manufacture. About $3 billion of this is military equipment.

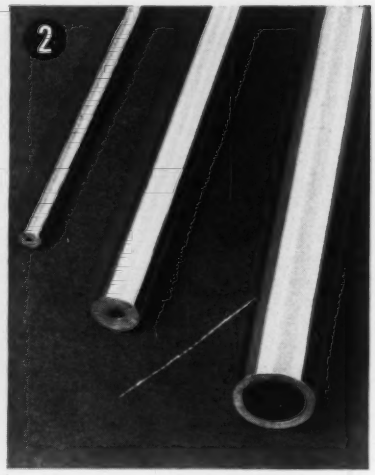
CAA is asking Congress for $810 million for a 6-year air-traffic-control plan, mostly for radar and communications equipment. This includes VORTAC—$255 million; long-range radar—$86 million; terminal radar—$58 million; ILS—$58 million; radar beacons—$24 million.

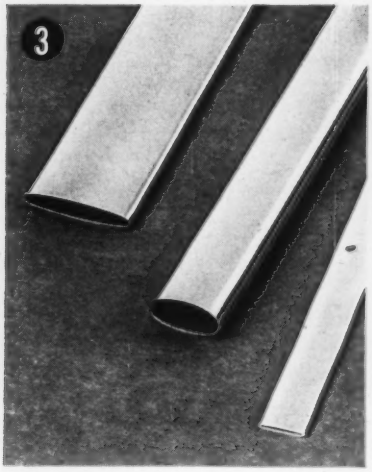
Capacitor manufacturer reports price cuts and profit losses in tight radio-TV market. Industrial field is only capacitor market with firm prices and good profit margin. Reason: Industry stresses quality, not quantity.

Speeds up to 9200 mph and altitude of 600 miles are unofficially reported by the Air Force research missile X-17.

TUBEXPERIENCE IN ACTION

TO MEET YOUR NEEDS Superior application...UNUSUALLY WIDE





Take advantage of Superior's unequalled variety of instrument tubing. Now you can select tubing from a wide choice of analyses (over 120), sizes, shapes, and mechanical properties. All tubing is produced to extremely close tolerances, finished with bright, clean, uniform surfaces.

1 Mechanical Tubing—Instrument Line

Produced in both seamless and Weldrawn forms, generally to meet such requirements as special OD-ID or ID-wall limits; special analysis or heat selection; controlled mechanical properties; and special finishes. Extra-long straight or coiled lengths or specific cut or multiple lengths. Cut and multiple lengths up to 39 ft. maximum. Coil lengths up to 500 ft., depending on material and size desired.

2 Pressure and Super Pressure Tubing

Made from specially selected raw materials which have had inside surfaces conditioned to remove fissures and other defects. Produced in stainless, carbon and alloy steels to carry pressures as high as 100,000 psi. Finished tubing must meet special inspection standards. Super pressure tubing is available in single wall, which will give long reliable service at lower working pressures, or in composite wall to withstand higher pressures. Used in hydrogenation process equipment and high pressure autoclaves.

3 Bourdon Tubing

Superior's wide range of alloys and sizes makes it possible to satisfy any set of service conditions—such as high strength, low hysteresis, corrosion resistance, etc.—for Bourdon tubing in indicating and recording instruments. Many different analyses to choose from, including Ni-Span C. Helix and spiral as well as "C" tube elements are fabricated from the many analyses which Superior offers. Smooth, clean surfaces, close dimension control, freedom from decarburization, accurate shaping and cleanliness, all combine to produce Bourdon tubing of unexcelled quality.

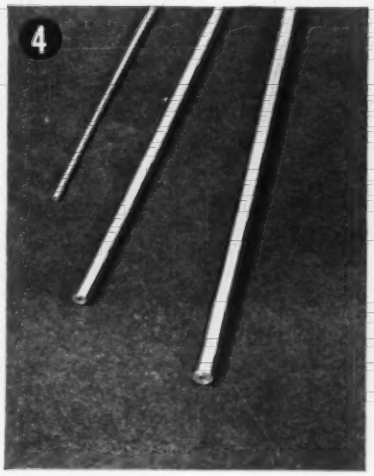
4 Capillary Tubing

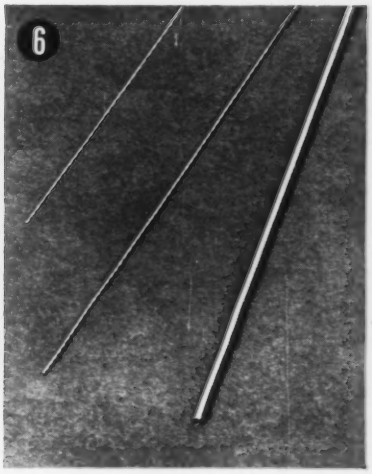
Superior capillary tubing is used for transmitting temperature and pressure impulses from the source to a recording or indicating instrument. Any outside diameter can be produced up to and including $\frac{3}{16}$ in. OD. IDs range from .004 in. minimum to .080 in. maximum. Has smooth ID, extreme ID uniformity, excellent corrosion resistance, and is easy to weld, braze or solder. Types 304, 316, 321, 347 and 446 stainless, Monel, Inconel, nickel

For more information circle **31** on inquiry card.

produces 6 types of tubing for any instrument

RANGE OF SIZES AND ALLOYS





and carbon are recommended analyses. Can be produced in straight lengths or long coils.

5 Large OD Thin Wall Tubing

In sizes to 2 1/2 in. OD, large diameter thin-wall tubing is available in Types 304, 321 and 347 stainless steel. In other stainless analyses the limit is 1 1/8 in. OD. It is also available in 16 additional ferrous and nonferrous analyses. Is easily fabricated and has been used in such applications as bellows, flexible metal hose, and instrument casings. Available in both seamless and Weldrawn® (welded and drawn) forms. In a variety of tempers.

6 Needle Tubing

For years Superior has made the finest stainless steel hypodermic needle tubing available. Originally developed to provide free, sterile passage for fluids, this tubing is now used for a wide variety of industrial applications such as tips and fountain parts in continuous inking equipment, nozzles for the application of lubricants, for dispensing minute, accurate quantities of liquids in microchemical work. The high strength, stiffness and strict dimensional tolerances of this tubing make it ideal for instrument application.

Your nearest Superior warehouse distributor can help you with any tubing problems—may often offer money-saving recommendations. If you do not know the name of the Superior warehouse distributor for your area, tell us to furnish you with it.

For a free copy of Bulletin 40—"A Guide to the Selection and Application of Superior Tubing"—write Superior Tube Company, 1968 Germantown Ave., Norristown, Pa.

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

All analyses .010 in. to 3/8 in. OD—certain analyses in light walls up to 2 1/2 in. OD

West Coast: Pacific Tube Company, 5710 Smithway St., Los Angeles 22, Calif. RAymond 3-1331

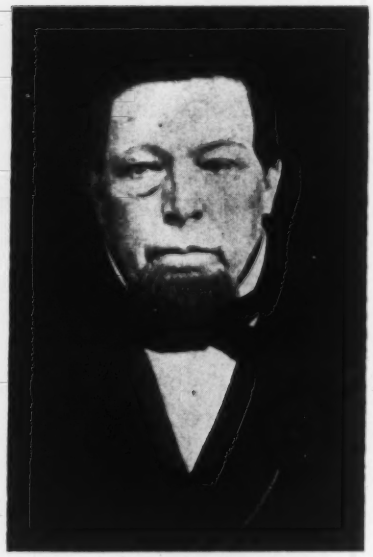
For more information circle **31** on inquiry card.

The O. J. Digitized Computer

"I see in this here magazine (March '57 *INSTRUMENTS AND AUTOMATION*), Cuz, where it says there's more than twenty five commercial digital computers on the market and I don't see where Wallace Electronic Service Company is listed amongst them as has their characteristics on page 450," remarked Waldo Klapsaddle, genial Sales Manager of WESCO! one day as we sat out on the riverbank, counting the number of steamboats going up and down the Ohio on our Model O. J. Computer. (The steamboats were *not* going up and down the river on the computer.—Ed.). Why don't you write up something for this here magazine you work for Cuz," said Waldo as he tore off a page from the magazine to roll a home-made cigarette. "And spread the good word to all the users of computers. And tell the Editor that I'm going to quit taking this magazine unless he gets better-smoking paper." At this point Waldo collapsed weakly on the riverbank in a nicotine fit. (My gosh. *another* complaint.—ED.)

Well, when one stops to think about the situation, it *is* strange in this day and age of rapid decision, high costs, juvenile delinquency, no-parking, alcoholism, H-bombs, B. O., and triple-toned automobiles that we haven't publicized our Model O. J. Computer—the computer for people with low I.Q.

Unlike all other digital computers, the Model O.J. has but two parts—the operating-readout circuit and the memory device. By not needing any circuitry or mechanism for input devices, our computer has been simplified to the extent that a child can operate it. It adds and subtracts without any gated clocks or any kind of logic, least of all diode logic, either serially or parallelly. It multiplies and divides in the old-fashioned way—none of this shifty business for us. Since the capacity of our memory circuit is approximately 20,000,000 (or is it 20,000,000,000? —What's a few bits among friends?) one can easily overlook the two short-comings of our computer: It is



Dr. Otto Uber Alles, BS, BA, MA, SB, CORG, JHU
Director of Research, Wesco!

pretty slow and sometimes one has a hell of a time getting any information from the memory tank. Waldo has been known to spend all morning computing $(0.1)^{\frac{1}{2}}$. On the other hand, things are pretty pokey down at Long Bottom most of the time so these defects give one time to enjoy the full life resulting from the application of Automation to our everyday problems.

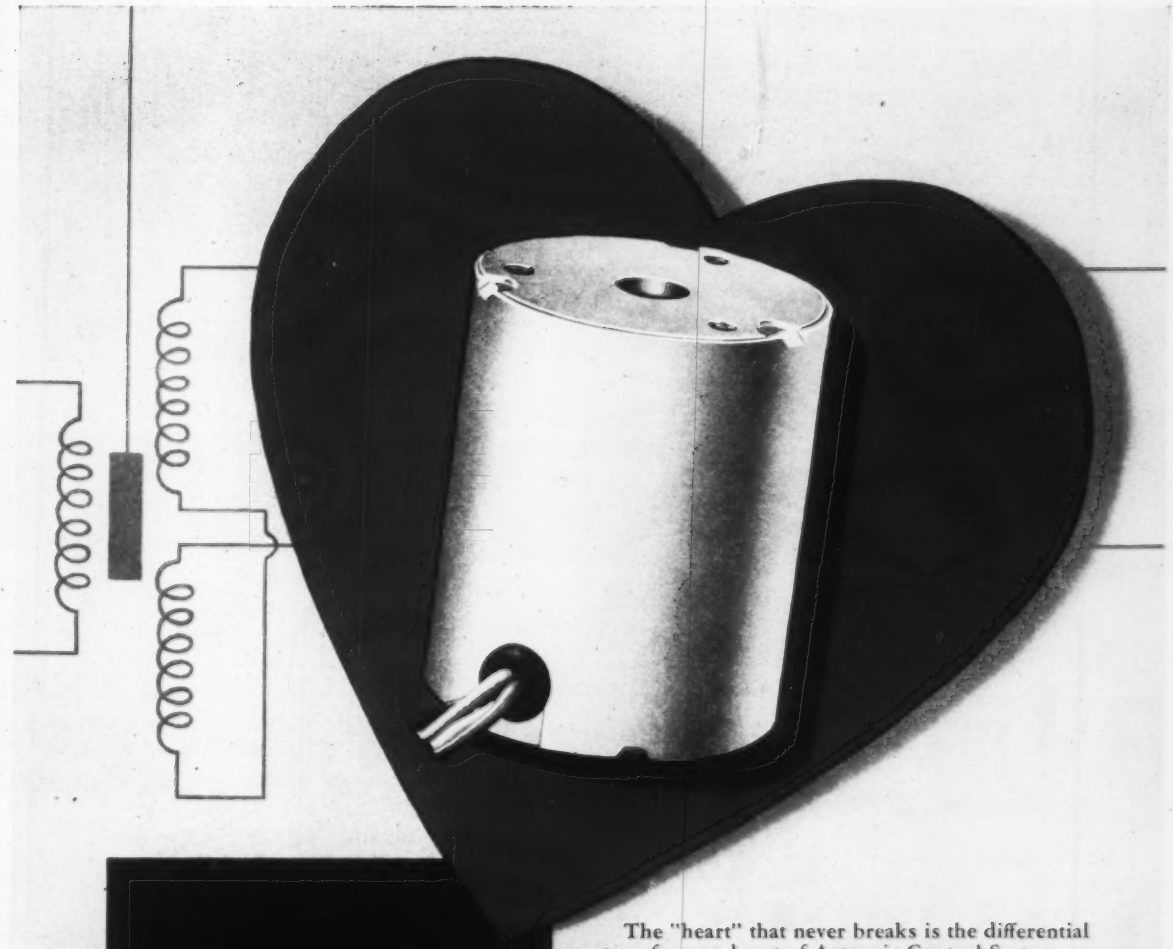
To begin with, our computer, a general-purpose machine in the economy class, is not based on the binary numbers but, rather, on the dewey-decimal system because the dewey-decimal system is easier to use. Obviously a man has ten fingers and two big toes, and Waldo uses all of them. A technique has been developed by our Dr. O.U. Alles for converting from decimal to binary to dewey-decimal system. This system, called the triple-twottle, starts with the left-most of the 20,000,000,000th bit and proceeds to the 9,999,999th bit where it changes over to the right big toe. If the next bit is then equal to pi/3, one triples the remainder and what is left is called twottling.

Another feature of the Model O.J., and one which no other computer manufacturer has ever attempted to build into his machine, is the ability to solve abstract equations directly. Since we don't need a Truth Table or Logic Chart for the computer, we are not limited by these restrictive features and hence our computer functions outside the realm of truth and logic. You can take a problem such as "Should I fire all my superintendents and instrument men and hire one good systems engineer?"

An invaluable co-function of this unique machine-circuitry is the impossibility of false statements from the computer. As the speed of the machine is slow, there is no need for patch bay verifiers, plug-in pot padding turret accumulators, Z-function diddle pots, or maximum-minimum excursion indicators (people can consult their travel agency for this purpose). This cleanliness of circuitry results in "Yes" or "No" information from the philosophical section, and whole numbers from the numbered numeral section. (This was developed from the works of Luigi Sassafrassio, the eminent Italian Mathematician of the 14th Century.)

To operate our Model O.J., one levels the operating read-out circuitry with the spirit-level provided, drinks the spirits, and then applies the tripolar digital platen to the leveled plinth-like platform upon which the platen perambulates. Next, one applies his ten digits to the digital platen or, if a co-function, usually female, is present, she applies her ten digits also and the effect of twenty digits of force and 40,000,000,000 bits of information is astonishing. Once these simple instructions are mastered, this computer should be as popular as a sandpile is to cats. When not in use, this computer can be folded up and used as a door-stop or taken on summer picnics for a table. For further information, encircle the card.

Panhandle Pete



here's the heart that never fails in

Swartwout Autronic Controls

The "heart" that never breaks is the differential transformer, heart of Autronic Control System transmitters.

Whether for measuring pressure, flow, level, or any displacement, you can't match the rugged simplicity of a differential transformer. There are no orifices . . . no vacuum tubes or transistors . . . no moving parts to cause shut-downs or maintenance problems. In addition to its reliability under adverse environments, the differential transformer has many distinct advantages over all other sensing devices. Among these are infinite resolution . . . performance that's linear to better than 0.1% of span . . . high signal output level . . . low impedance . . . ability to add, subtract or average signals.

The military specifies differential transformers for the toughest assignments. How about you? *You'll go all-electronic eventually—Go Autronic now with Swartwout, pioneer and leader in electronic controls.*

AA-3948

Swartwout

AUTRONIC® CONTROLS

THE SWARTWOUT COMPANY,
18511 EUCLID AVENUE,
CLEVELAND 12, OHIO

For more information circle **32** on inquiry card.

8 big extras you get

WHEN YOU BUY

Bristol Instruments

Here's how Bristol can help you with an integrated, nationwide service organization

FACTORY REPAIRS AND SERVICE are available on Bristol instruments at San Francisco, Los Angeles, Chicago, Houston, and Toronto, as well as at Waterbury. Each reconditioned instrument carries a "new" guarantee.

EDUCATION FOR AUTOMATION. Instruction is offered in THE BRISTOL INSTRUMENTATION SCHOOL for customers' engineers and technicians on latest techniques in instrumentation. Widely attended, too, by professors from the leading technical schools.

For more information circle **33** on inquiry card.

1. FIELD ENGINEERING. Bristol field engineers are ready to serve you from offices located throughout the United States and Canada. Years of training and experience in applying instruments in all types of plants enable them to recommend the equipment best suited for your job. They call at your plant, without obligation or cost, to assist you in planning proposed instrument installations.

2. APPLICATION ENGINEERING. Our application engineering department includes specialists in every type of measuring or controlling instrument. These men are completely familiar with the abilities, limitations, and accessories of their particular specialty. And they know the methods of installation and operation that assure the best possible performance.

3. PROCESS SPECIALISTS. Process instrument experts, each a specialist in a particular industry, are ready to advise you on up-to-the-minute instrument systems for tough or unusual processes. Their correctly planned installations and accurately specified instruments save delivery and installation time and make for successful operation.

4. FIELD CHECK-UP SERVICE. A nation-wide staff of factory-trained, widely experienced Bristol service engineers gives you personal assistance in servicing your Bristol instruments. For a reasonable rate, they install, check, adjust, and inspect Bristol instruments in your plant. They are available on short notice—often within a few hours. Regardless of your location, Bristol service is "on call" at any time to help you get the most out of your Bristol instruments.

5. PERIODIC CHECK-UP SERVICE. A systematic plan of preventive maintenance and repair is available to users of Bristol instruments to keep their equipment in good operating condition. In this plan, a Bristol Service Engineer calls at regular intervals to inspect the instruments and make minor repairs before serious wear or damage can take place. These preventive measures guard against breakdowns at critical periods.

6. FACTORY REPAIR SERVICE. Factory repair facilities at San Francisco, Los Angeles, Chicago, Houston, Waterbury, and Toronto are available to repair, recondition and remodel Bristol instruments. All phases of fabricating, testing, calibrating, repairing, and remodeling Bristol instruments are performed at these branch factories by trained workmen, experts through years of experience in our production methods. Only genuine Bristol parts are used. *Each instrument reconditioned in any branch factory carries a new instrument warranty.*

7. FAST PARTS SERVICE. Service parts, such as may be needed in emergencies, are stocked by our branch offices. Everything possible is done to ship service parts and accessories promptly.

These big extras you get with Bristol instruments are good reasons—over and above outstanding basic instrument quality—why every Bristol installation gives such high accuracy and precision performance over an extremely long service life. When you buy Bristol instruments you can get service when you want it, regardless of where you are located. To find out more about Bristol instruments or service, write: The Bristol Company, 113 Bristol Road, Waterbury, Connecticut. 6.75

8. WRITE FOR BRISTOL TECHNICAL DATA—reputed to be the most outstanding present-day source of Instrument Engineering Data on the following subjects:

- Absolute pressure gauges
- Air-operated controllers
- Automatic control instruments
- Barometers
- Bridge instruments
- Combustion safeguards—electronic—Pyrotrol
- Coordinated process control—Process automation
- Cycle controllers
- Draft gauges
- Electric recorders
- Electrolysis survey recorders
- Electronic bridge instruments
- Electronic potentiometers
- Flow meters—Mechanical and Electric
- Gauges—pressure, vacuum, draft, absolute pressure, liquid level
- Humidity controllers and recorders
- Liquid level gauges
- Load totalizing with Thermoverter*
- Metameter* Telemeters
- Motion, operation, running-count and running-time recorders
- Production recorders
- pH control instruments
- Pneumatic transmission systems; Metagraphic and Metavane*
- Potentiometers, electronic
- Pressure and vacuum gauges
- Process control instrumentation
- Pyrometers
- Recorder charts
- Resistance thermometers
- Smoke density recorders
- Specific gravity instruments
- Speed recorders
- Telemetering instruments
- Thermocouples, pyrometer tubes and accessories
- Thermometers
- Time-program controllers
- Valves, automatic

*T.M. Reg. U. S. Pat. Off.

Ask for information on the subject of interest to you. We'll be glad to send it.

BRISTOL

TRAIL-BLAZERS IN PROCESS AUTOMATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle 33 on inquiry card.

NOW

pressure measurements to 5000 psi

...at 600°F

COMPANION TO THE 4-316... Only CEC offers two miniature pressure pickups with these exclusive advantages: Both the new 4-317 and the 4-316 operate on the unbonded-strain-gage principle... together they cover a pressure range of 15 to 5000 psi gage, operating continuously at 600°F. Sizes are ⅝" and ½" nominal diameters for the 4-317 and 4-316, respectively; weights, 55 and 23 grams with mounting flanges.

CEC's NEW 4-317 PRESSURE PICKUP Offers gage pressure ranges of 100, 150, 250, 500, 1000, 1500, 2500, 3500, and 5000 psi... can be operated continuously without damage at 5 volts maximum input over a temperature range of −350°F to +600°F with allowable transients up to +750°F. Linearity and hysteresis combined are less than ±1.5% of full-range output over the stated temperature range. Allowable acceleration is 100 "g" in any axis. One-piece construction of diaphragm and case from 416 stainless steel assures that no foreign substances will come in contact with the measurement fluid.

CEC's 4-316 Pressure Pickup offers similar advantages in the pressure ranges from 7.5 to 150 psi. Contact your nearby CEC field office, or write for Bulletins CEC 1568-X28 and 1588-X2.

Consolidated Electrodynamics

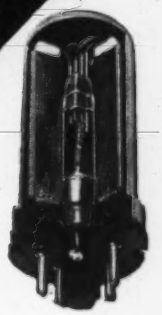
300 North Sierra Madre Villa, Pasadena, California

OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

For more information circle **34** on inquiry card.

CLARE RELAYS and AUTOMATION

Cutaway view of CLARE Mercury-Wetted-Contact Relay, two of which are used by AccuRay to control cigarette making process.



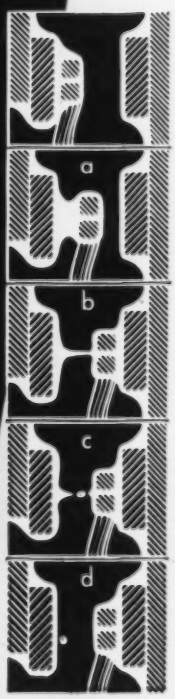
How *AccuRay* uses long-life CLARE Mercury-Wetted-Contact Relays to provide accurate, continuous and automatic control of a manufacturing process

Actuated by variations in the electric current set up by a constant intensity beam of radiation through a cigarette "rod," two CLARE Mercury-Wetted-Contact Relays help the AccuRay Cigarette-Gauge controller to proportion the weight of cigarettes as they are being produced.

In this way AccuRay, a revolutionary precision process control system, uses electronics to provide automatic control of cigarette and other manufacturing production processes.

Engineers of Industrial Nucleonics Corporation, makers of this new process control, picked CLARE Relays to perform these important functions because only these relays gave the long life and low maintenance required. These machines wrap and cut 20 cigarettes a second, day and night, day after day.

With a service life of billions of operations* it is no wonder this relay has become the first choice of hundreds of leading designers of computing, data-processing and control equipment. For complete information write for Bulletins 120 and 122 to C. P. Clare & Company, 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: 659 Bayview Avenue, Toronto 17. Cable address: CLARELAY.



Drawings (left) from high-speed photographs show the cycle. (a) Filament of mercury forms between the contacts as they separate. (b) This becomes narrower in cross section and (c) finally parts at two points, allowing globule of mercury to fall out. Mercury flows up the capillary path, replaces amount lost, restores the equilibrium. (d) The momentary bridging of the parting contacts—and the extremely fast break that ends it—minimizes the arc and adds greatly to contact load capacity. Contact closure between the two liquid surfaces bridges mechanical bounce and prevents any chatter from appearing in the electrical circuit.

More than two years ago a life test started on a group of these relays carrying a full contact load of 5 amperes at 50 volts d-c with suitable spark suppression. They have been operating continuously ever since at 5,184,000 operations a day. They have now passed the 4 billion mark—and the end is not yet in sight.

CLARE RELAYS

FIRST in the industrial field

© Industrial Nucleonics Corporation, Columbus, Ohio

For more information circle 38 on inquiry card.

SIGNIFICANCE

UOP (Universal Oil Products) is well known for significant process control developments, including the graphic panel. Behind many of these developments has been Dave Boyd, one of the best known instrument men in the process control field. His biography brings out the key functions of the instrument specialist in an industry that develops and constructs processes used in refineries. This month we are pleased to acknowledge the key position of Dave Boyd and his many contributions in the field of process instrumentation. Perhaps the most significant of these contributions is to be found in his recent work analyzing the specific operational benefits to be realized from the rapid response of electronic process controllers. Among the millions of words spent on the debate on this subject, Dave's works in this field is unique in being factual and noncontroversial, showing exactly the type and magnitude of response.

Biographies of significance

DAVID M. BOYD, JR.

Ten years ago doctors told Dave Boyd's family that he would never walk again. He was a victim of polio, and an iron lung awaited outside his hospital door for any eventuality. But Dave Boyd—the "Little Bulldog" as he is known to his friends—did not use the iron lung. Within a few months he was walking again, with the help and encouragement of his wife, who gave him the spark needed to overcome this dread disease.

Dave contracted polio while assigned to the Oak Ridge, Tennessee, National Laboratories, where he worked on projects for the Atomic Energy Commission on a loan arrangement with Monsanto Chemical Company. When he left Oak Ridge after two years' work, he was head of the instrument application group.

Electronics have been Dave's hobby since he graduated from the University of Colorado in 1941 with the degree of Bachelor of Science in Chemical Engineering. He first worked for the Barrett Chemical Company in Philadelphia, and in his spare time built a TV set from parts he picked up here and there. The officials of Barrett Company heard about his TV set—which Dave says "worked like a charm"—and transferred him to the instrument department. After about a year with this firm, he joined Blaw-Knox where he worked on designs for synthetic rubber plants.

A year and a half later he was head of the instrument department for Eastern States Petroleum Company in Houston, Texas.

During this early career he continued to dabble in electronics. By the time he joined Universal Oil Products Company in 1948, electronics had become a major hobby.

His present basic functions are the design and specification of control systems on new UOP refinery processes, and assisting in the installation and startup of these units, as well as advising on the servicing of instruments on existing facilities of UOP customers. His instrument organization consists of 15 engineers including chemical, electrical, mechanical, and civil.

Personnel of the instrument department are constantly on the alert for better ways of controlling UOP-licensed process units. They are in on the ground floor of the instrumentation of refinery units, and have service contact with each unit throughout its life. An outgrowth of this interest has already been indicated in the installation of the first graphic panel in 1949 and, more recently, the all-electronic control system.

This instrument department accounts for the design of a large share of the instruments used in new refinery construction throughout the world. Last year, for example, 31 graphic panels and their field transmitters and valves were designed and engineered here.

But electronics are only one of many avocations of this 39-year-old engineer who has carved an important place for himself in the instrumentation field. Shortly after becoming associated with UOP, he designed his own home in Clarendon Hills, Ill., a suburb of Chicago. His home, which he also built as general contractor, features copper-coil radiant heating in the ceilings. Ground was broken in June, 1949, and Dave, his wife, Louise, and their children, Garry and Gwen, moved in on Christmas Eve. The Boyd's now have another daughter, Barbara, 7 years old.

Dave has earned his nickname of "Little Bulldog" because of his tenacity in solving complex instrument problems. Dr. D. J. Bergman, chief engineer for Universal Oil Products Company, and one of those who calls Dave by his nickname said, "You can always rely on him to be starting something which will result in better automatic control. Dave Boyd is an outstanding example of creative thinking."

Dave has two patents issued in his name, both assigned to Universal Oil Products.

In 1950 Dave was awarded an honorary degree in chemical engineering from his Alma Mater for developing the graphic panel.

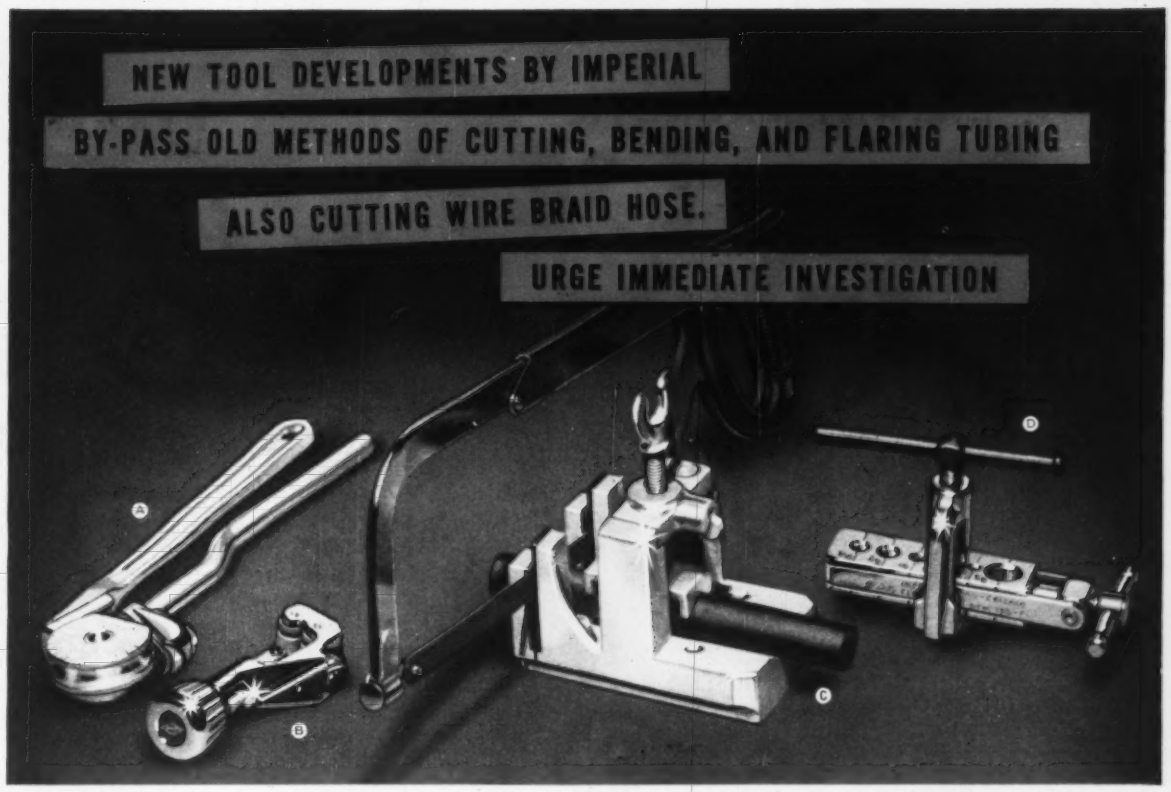
He has served as vice president of the Instrument Society of America in 1952 and 1953. He is a member of the American Society of Mechanical Engineers, American Institute of Chemical Engineers, American Chemical Society, and a senior member of the Institute of Radio Engineers.

NEW TOOL DEVELOPMENTS BY IMPERIAL

BY-PASS OLD METHODS OF CUTTING, BENDING, AND FLARING TUBING

ALSO CUTTING WIRE BRAID HOSE.

URGE IMMEDIATE INVESTIGATION



Ⓐ **Bends hard or soft tubing.** Open side design. Forms neat, accurate bends, any angle up to 180°. Calibrated. Specify No. 364-FH "Blue Dot" bender. Sizes: 1/8 to 3/4" O.D. tubing. Individual benders for each size.

Ⓑ **Spare cutting wheel now included at no extra cost with this tube cutter!** Fits behind retractable reamer. Instantly available. Cutter has free-wheeling, ball-bearing action. No. 274-F Hi-Duty tube cutter for 1/8 to 1" O.D. tubing.

Ⓒ **For sawing wire-braid pressure hose or metal tubing.** Assures square, clean cuts. Minimum wear on hacksaw blade due to special gripper. Extra-tight slide-to-size clamping. For 3/16 to 1 1/2" O.D. hose or tubing. No. 384-F bolts to bench or clamps in a vise.

Ⓓ **Industrial hard chrome cones now furnished on Imperial flaring tools.** No extra cost! Smoother flares, up to 55% easier! Types for 45°, 37° and double flares. No. 300-F for 45° flares. No. 437-F for 37° flares. Sizes: 3/16, 1/4, 5/16, 3/8, 1/2 and 5/8" O.D. tubing.

Imperial offers you industry's most complete line of tube working tools with more work-saving features!

If it's new . . . it's from Imperial! The complete tubing tool line with more "firsts" to its credit continues to take the "work" out of tube working with *more* new developments!

That means no matter what the tubing . . . copper, aluminum, steel or stainless steel . . . or the type of job, you're adding greater accuracy, speed, ease and better craftsmanship to cut costs right down the line. *Tool up with Imperial and be first with the latest!*

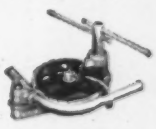
Avoid lost time and grief by replacing labor-wasting tools NOW with years-ahead IMPERIAL tubing tools. See your Imperial distributor now, or write for Catalog 3011.

No. 500-F and No. 507-F Rol-Air flaring tools for 45° and 37° flares.

No. 140-F Test plug — for closing end of tube temporarily. Pressures to 100 lbs.

No. 206-F — Adjust-o-matic, slide-to-size tube cutter. For 3/4" to 2 1/4" O.D. Tubing.

No. 400-F flares stainless steel, titanium — other metal tubing to AN standards.



No. 270-F Gear type bender bends any type of tubing.

No. 260-F tube bender combination for 7 sizes: 1/4 to 7/8" O.D.

IMPERIAL

THE IMPERIAL BRASS MFG. CO.
1204 W. Harrison St., Chicago 7, Ill.
In Canada: 334 Lauder Ave., Toronto, Ontario

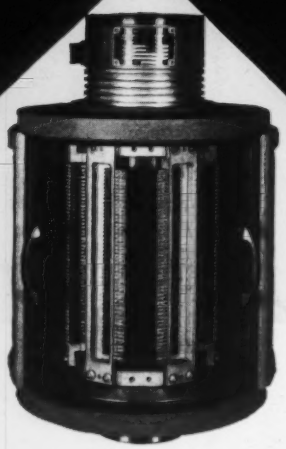
Emblem of Quality

For more information circle **36** on inquiry card.

The New

BRYANT MAGNETIC STORAGE DRUM

Economical . . . Precise . . . and Versatile!



The new 512A Bryant general purpose magnetic storage drum is built to meet the exacting requirements of all permanent storage problems, yet is versatile enough to be used as a laboratory instrument. It is the result of 25 years' experience in designing and producing high-speed precision spindles. These standard 5" dia. x 12" long drums are stocked for immediate shipment at a price that reflects quantity manufacture, far below the cost of customer-designed drums.

Features:

- Guaranteed accuracy of drum run-out, .00010" T. I. R. or less.
- Integral motor drive—Bryant precision motor
- Capacities to 625,000 bits
- Speeds up to 12,000 R. P. M.
- 500 kilocycle drum operation possible
- Accommodates up to 240 magnetic read/record heads
- Provides for re-circulating registers as well as general storage
- High density ground magnetic oxide coating
- Super-precision ball bearing suspension
- Vertical mounting for trouble-free operation

Write for complete details on the new No. 512A

BRYANT GAGE and SPINDLE DIVISION
P. O. Box 620-I, Springfield, Vermont, U. S. A.
DIVISION OF BRYANT CHUCKING GRINDER CO.

For more information circle **37** on inquiry card.

Events

October 7-9

National Electronics Conference, Hotel Sherman, Chicago. For information write National Electronics Conference, 84 E. Randolph St., Chicago 1, Ill.

October 7-9

1957 International Systems Meeting, Statler Hotel, Los Angeles, Calif. For information contact Leslie H. Matthies, 629 S. Hill St., Los Angeles 14, Calif.

October 10

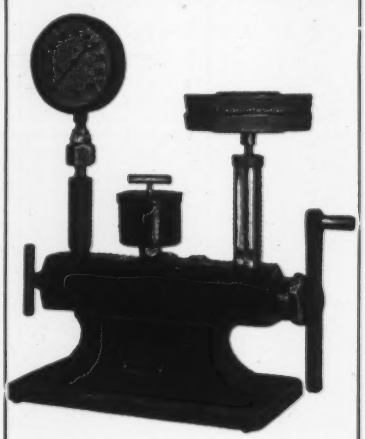
Reliability and Quality Control in Electronics conference of the A.I.E.E., Silver Springs, Md. For information write A.I.E.E., 33 W. 39th St., New York 18, N. Y.

October 15

DDA Council Meeting, I.A.S. Building, Los Angeles, Calif. Host will be Packard-Bell Computer Corp.

Continued on page 1673

AMTHOR Dead Weight Pressure Gauge TESTER



Designed for simplicity and compactness, this tester incorporates the newest refinements and improvements and is praised by users in all industries for long lasting troublefree service. Made in ranges up to 10,000 P.S.I. We guarantee accuracy of 1/10 of 1%. Supplied in metal carrying case with adapters and tools. Weighs in special metal container for storing.

Ask for literature also on Tensile Testers, Indicating and Recording Tachometers and Thickness Gauges.

Amthor
Testing Instrument Co., Inc.
498 Van Sinderen Ave., Brooklyn, N. Y.

For more information circle **38** on inquiry card.

FACTS

about

NEW DEPARTURE BALL BEARINGS

for

GIANT JETS

or

TINY INSTRUMENTS

From high-capacity mainshaft turbine bearings of special steels and finish, stabilized for high temperature operation, down to tiny precision instrument bearings of exquisite accuracy—look to New Departure as the source you can rely on. For New Departure has the experience, the equipment and the ability to produce the world's finest ball bearings.

Turbine bearings with two-piece inner rings in bore sizes from 25 to 220 millimeters. Send for catalog ABC.

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Precision instrument bearings in bore sizes from 3/64 to 3/8 inch. Send for catalog PIB.

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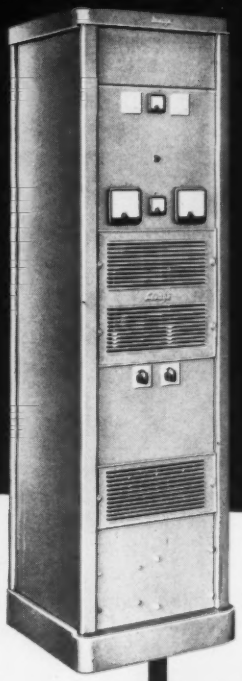
6 cps to 100,000 cps at
1,000 WATTS CONTINUOUS DUTY
...with the new Genisco-Savage high-output amplifiers!



Here's the new line of quality, high-output amplifiers you've been waiting for! All seven models feature high power output, low distortion, exceptionally high reliability and stability, and excellent output voltage waveform.

The Model KLF, shown at left, is particularly useful as an exciter for vibration testing equipment and as a variable frequency power supply for a multitude of production and laboratory needs. It will operate *continuously* with an output of 1,000 watts from 6 to 2,000 cps.

Components of all Genisco-Savage Amplifiers are mounted on 19" vertical panels to facilitate easy inspection and maintenance. Quick-release grill covers make all tubes readily accessible from the front. Numerous built-in safety features protect the equipment from operator errors.

Two New Shake Tables Available The new Model V1000 Genisco-Savage Shaker features a very light moving coil assembly, high thrust-to-weight ratio, automatic impedance matching, and an excellent output waveform. A continuous alternating thrust of ±600 lbs. is produced at 1,000 watts control power. Thrust can be increased to ±750 lbs. peak by use of a blower (Model V1000B). Both models have been stress-tested to withstand continuous operation at accelerations of 100 G's.

Seven models—rugged enough for production line testing; versatile enough for almost all laboratory needs.

The Genisco-Savage Model V1000 Shaker

BRIEF SPECIFICATIONS	MODELS						
	BM2	DM2	KM2	10K	KM2S	KLF	KRF
Output	250 w at 50 or 100 v	500 w at 50 or 100 v	1000 w at 50 or 100 v	10,000 w maximum	1000 w at 50 or 100 v	1000 w at 50, 100, or 200 v	1000 w at 25, 50 or 100 v
Frequency Range	50 to 10,000 cps at 250 w	50 to 10,000 cps at 500 w	50 to 10,000 cps at 1000 w	40 to 10,000 cps at 10,000 w	50 to 10,000 cps at 1000 w	6 to 2000 cps at 1000 w	5 to 100 kc at 1000 w
Sensitivity	0.036 v at 600 ohms	0.04 v at 600 ohms	0.1 v at 600 ohms	0.16 v rms at 600 ohms for 10,000 w output	0.1 v at 600 ohms	0.05 v at 600 ohms	0.5 v at 600 ohms
Distortion	1% at 250 w, 1000 cps	0.75% at 500 w, 1000 cps	Less than 0.75% at 1 kw, 1000 cps	Less than 3% at 10 kw, 1000 cps	Less than 0.75% at 1 kw, 1000 cps	Less than 5% at 1 kw, 10 to 1000 cps	

Price and delivery of both amplifiers and shakers are exceptionally good. For complete specifications and prices send for the new four-page illustrated brochure.

Genisco, Incorporated
2233 Federal Avenue
Los Angeles 64, California

For more information circle **40** on inquiry card.

EVENTS —CONTINUED

October 17-18

National Conference on Industrial Hydraulics, Sherman Hotel, Chicago, Ill. For information write Armour Research Foundation, Illinois Institute of Technology, 10 W. 35th St., Chicago 16, Ill.

October 18-19

Conference on Automation will be feature of Professional Engineers Of Oregon Annual Meeting, Eugene, Oregon. For information write Phillip L. Cole, 1221 S.E. 71st Ave., Portland 16, Oregon.

October 24-25

Computer Applications Symposium, Sherman Hotel, Chicago, Ill. For information write Armour Research Foundation, Illinois Institute of Technology, 10 W. 35th St., Chicago 16, Ill.

October 24-25

14th Annual Display of Aircraft Electrical Equipment sponsored by the Aircraft Electrical Society, Pan Pacific Auditorium, Los Angeles, Calif. For information write Ed Ryerson, 6901 Melrose Ave., Los Angeles 38, Calif.

November 2-10

INTERKAMA (International Congress and Exhibition of Measuring Instrumentation and Automation), Dusseldorf, Germany. For information write Nordwestdeutsche Ausstellungs-Gesellschaft m. b. H., Ehrenhof 4, Dusseldorf, West Germany.

November 6-8

I.R.E. 1957 Aero-Com Symposium, Hotel Utica, Utica, N. Y. For information write R.A. Zachary, Vice Chairman for Technical Program, 11 Arbor Drive, New Hartford, N. Y.

November 7-8

7th Annual Symposium on New Ideas in Instrumentation Evolved from Nuclear Developments, Sheraton Hotel, Philadelphia, Pa. For information write Warren Brand, Conoflow Corp., 2100 Arch St., Philadelphia 3, Pa.

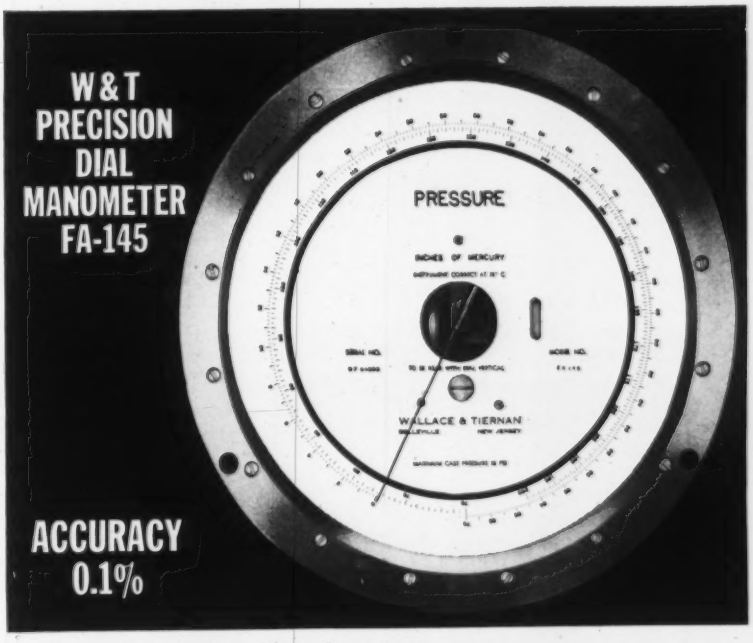
November 11-13

Instrumentation Conference and Exhibit, Institute of Radio Engineers, Biltmore Hotel, Atlanta, Ga. For information write B. J. Dacher, School of Electrical Engineering, Georgia Institute of Technology, Atlanta, Ga.

November 13-14

Mid-America Electronics Convention, Municipal Auditorium and Hotel Muehlebach, Kansas City, Missouri. For information write Richard L. Clarke, Midwest Research Institute, 425 Volker Blvd., Kansas City 10, Mo.

Continued on page 1676



PRECISION PRESSURE Measurement
of Gauge, Vacuum or Differential Pressures on Pneumatic Systems

Accuracy:	1/1000 of full scale
Sensitivity:	1/10,000 in *all* ranges
Ranges:	0 to 120 inches of water (min.) 0 to 300 inches of mercury (max.) Other intermediate ranges available
Scale Length:	45 inch scale in two revolutions
Dial Size:	8½ inches

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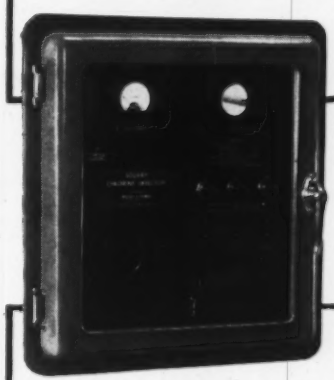
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY
In Canada, Wallace & Tiernan, Ltd. — Toronto
A-109



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New W&T Solvay Chlorine Detector*
detects as little as 3 p.p.m. chlorine in a continuous air-stream sample. Automatically sets off alarm at higher concentrations.
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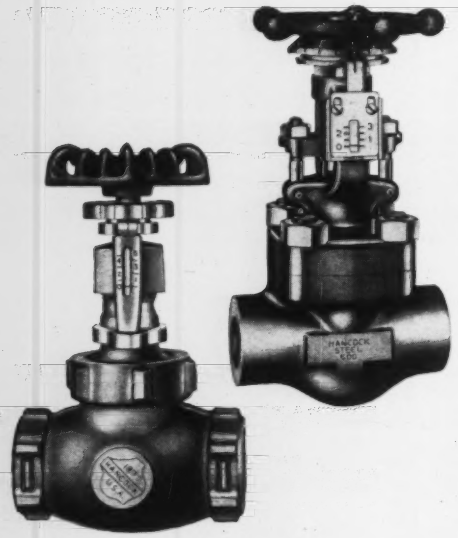
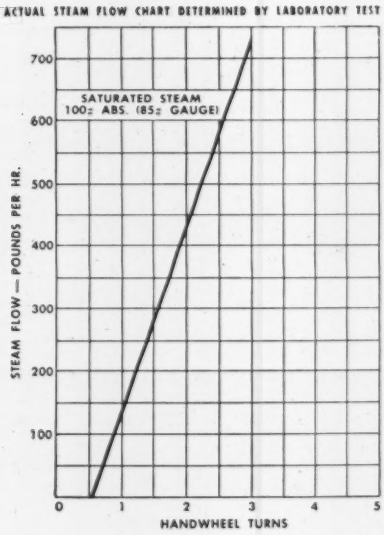




HANCOCK "Flocontrol®" VALVES

- ✓ **Insure Uniform Quality Through Closer Control**
- ✓ **Save Steam and Fuel on Process Work**
- ✓ **Save Money by Cutting Maintenance**

Hancock "Flocontrol" Valves provide a 3-in-1 design that combines variable orifice, shut-off and index. The valve opening can be set to within one-tenth of a turn of the handwheel. The micrometer dial and pointer make it easy to duplicate any desired setting instantly.

Each valve has a scientifically designed V-port valve disc that insures proportional flow throughout the entire lift of the stem. Straight line flow with separate shut-off seating surface removed from the controlling V-ports eliminates the need for a separate shut-off valve.

Hancock "Flocontrol" Valves are available in Bronze and Steel to meet specific requirements. All are rugged valves, designed and constructed to provide the *economy of quality* so essential to assure top performance in the most demanding services.

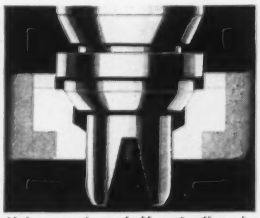
Hancock Bronze "Flocontrol" Valves. *Types:* Globe and Angle. *Sizes:* ¼" through 2". *Connections:* Screwed Ends. "500 Brinell" Stainless Steel Seats and Discs. 150# Series for all pressures up to 150 psi at 358° F. 300# Series for all pressures up to 300 psi at 550° F.

Hancock Forged Steel "Flocontrol" Valves. *Types:* Globe and Angle. Renewable Hard-Faced Stainless Steel Seats. "500 Brinell" Stainless Steel Discs. *Connections:* Screwed, Socket Weld and Flanged Ends. *Sizes:* Screwed and Socket Weld Valves—¼" through 2". Flanged Valves—½" through 2". *Screwed and Socket Weld Valves:* For all pressures up to 600 psi at 910° F. O.W.G.—2000 psi at 100° F. *Flanged Valves:* For all pressures up to 600 psi at 850° F. O.W.G.—1440 psi at 100° F.

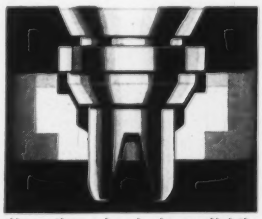
Hancock Cast Steel "Flocontrol" Valves. Globe Type with Screwed Bonnet. Renewable Stainless Steel Plug Seats and Discs. *Sizes:* 2½" and 3". *Connections:* Screwed and Flanged Ends. For all pressures up to 395 psi at 775° F. O.W.G. —720 psi at 100° F.

Hancock Cast Steel "Flocontrol" Valves. Globe type with Bolted Bonnet. Renewable Stainless Steel Plug Seats and Discs. *Sizes:* 2½", 3" and 4". *Connections:* Flanged Ends. 300# Series for all pressures up to 395 psi at 775° F. O.W.G.—720 psi at 100°F. 600# Series for all pressures up to 800 psi at 775° F. O.W.G.—1440 psi at 100° F.

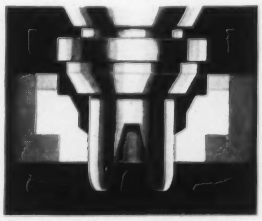
HANCOCK "FLOCONTROL" VALVES OPERATE LIKE THIS . . .



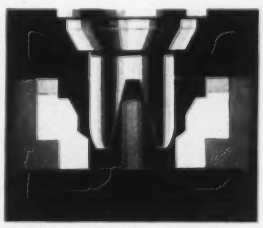
Valve seat and V-port disc in fully closed position. Pressure pushes upward under the disc. Note that the shut-off seating surface is completely removed and separate from the flow-controlling V-ports.



Here the valve is in a slightly opened position. The V-port disc is permitting a measured flow of the media.



This is the intermediate position. Note that the V-port disc now permits a proportionally greater flow of the media.



Fully opened valve provides maximum flow. The special micrometer dial and pointer permit any open position to be duplicated accurately.

YOUR INDUSTRIAL SUPPLY DISTRIBUTOR is as close as your telephone. Let him help you select the right Hancock "Flocontrol" Valves for your needs. You can depend on him for fast delivery from local stocks.

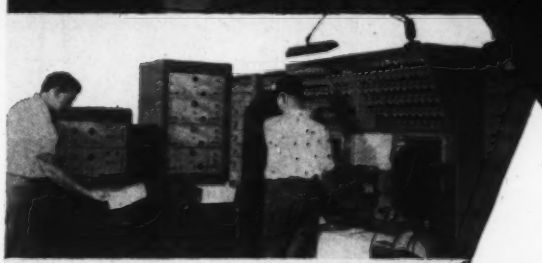
In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

HANCOCK VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** Watertown 72, Massachusetts

MAKERS OF 'ASHCROFT' GAUGES, 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury, Conn. and Inglewood, Calif.* "SHAW-BOX" and 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

For more information circle **42** on inquiry card.



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analog computer
readout:

modern, compact, mobile

SANBORN

CONSOLE RECORDING SYSTEMS

Up to eight problem variables can be recorded in inkless, permanent, rectangular-coordinate tracings – with Sanborn's improved six- and eight-channel 156-, 158-5490 Console Systems. Less than four feet high and about two feet in width and depth, these Systems are completely mobile and designed for maximum operating convenience. Controls and indicators on the sloping top panel include individual-channel attenuation, position, balance, sensitivity and stylus heat adjustments; switch for turning off B + of output amplifiers; chart drive motor switch (can also be remotely controlled); code marker and/or one-second interval timer stylus switch. The Recorder unit, either six or eight channels, features paper loading from the top, and nine precisely controlled speeds from 0.25 to 100 mm/sec. Four dual-channel DC Driver Amplifiers of current feedback design are housed below the Recorder, and are mounted on a chassis which may be withdrawn for inspection.

Electrical specifications of the Console Recording Systems include a basic sensitivity of either .01 volt/chart division (5490 types) or 0.1 volt chart division (5495 types); linearity of 1%; drift less than 1/2 chart division/hour (5490), less than 1/20 chart division/hour (5495); flat frequency response to 20 cps, down 3 db at 60 cps for all amplitudes to 5 cm peak; either single-ended or push-pull input signals of 5 meg. impedance (each input lead to ground).

A useful companion instrument is the new Sanborn Model 183 Programmer, designed to provide a connecting link between an analog computer and the Console Recording System. Shown mounted at the top rear of the Console, the Programmer operates the Console in the following automatic sequence: turns recorder drive on – feeds calibration signals to all channels – reads initial DC levels of computer – closes contacts to start computer problem – records computer output for a preset chart length – turns off recorder drive and resets itself for another cycle.

Further technical data, prices and delivery information – on the 5490/5495 Console Recording Systems and two- to eight-channel 5475/5480 Systems are available on request from your Sanborn Sales-Engineering Representative or the Industrial Division in Waltham.

SANBORN COMPANY

INDUSTRIAL DIVISION

175 Wyman Street, Waltham 54, Massachusetts

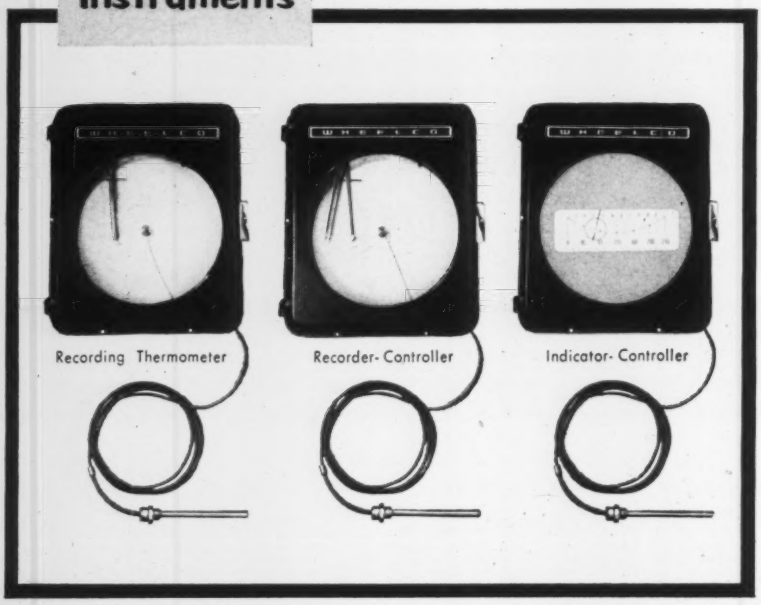
For more information circle **43** on inquiry card.

THE MARK OF QUALITY

BARBER COLMAN

Wheelco Instruments

New! 4000 Series Thermotrols for Indicating, Recording, and Controlling



New 4000 Series Thermotrols for indicating, controlling, or recording service have standard operating ranges of –40 to 1000° F. All are mercury-actuated with recorders being available as single-, two-, and three-pen units. A wide variety of control forms is possible because of plug-in chassis design.

Other outstanding features of the new Thermotrols line include: Invar metallic compensator for case, friction-free pen arms, electronic control action for controllers with the Wheelco "Electronic Link," and electric clock chart drives.

Bulletin F-8042 has more data on these new Thermotrols. It's available from your nearby Wheelco field engineer.

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For more information circle **44** on inquiry card.

EVENTS —CONTINUED

November 18-21

Conference on Magnetism and Magnetic Materials, Sheraton-Park Hotel, Washington, D. C. For information write John J. May, 552 Washington Bldg., Washington 5, D. C.

December 2-6

26th Exposition of Chemical Industries, New York Coliseum, New York. For information write E. K. Stevens, 480 Lexington Ave., New York 17, N. Y.

December 8-11

Eastern Joint Computer Conference, sponsored by IRE, AIEE and Assn. for Computing Machinery, Shoreham Hotel, Washington, D. C. For information write Morton M. Astrahan, IBM Corp., San Jose, Calif.

May 31-June 8, 1958

European Congress of Chemical Engineering and ACHEMA Congress, Frankfurt a.M., Germany. For information write DECHEMA, Dechema-Haus, Rheingau-Allee 25, Frankfurt a.m., West Germany.

June 9-13, 1958

Fourth International Automation Exposition, Congress, Conferences, and Clinics, New York Coliseum. For information write Richard Rimbach Associates, 845 Ridge Ave., Pittsburgh 12, Pa.

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AUTOMATIC & HAND SCREW MACHINES UP TO 4" DIA. — ENGLISH & METRIC THREADS OUR SPECIALTY

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. . . SPECIFY THIS DEPENDABLE CALIBRATOR FOR LOAD AND PRESSURE CELLS

Experienced engineers know that periodic re-calibration of their load and pressure cells is a "must". The electrical output characteristics of these transducers will determine the accuracy of future measurements, and the ALINCO Type C Calibrator is designed specifically for such calibration. Consider these transducer characteristics, for instance...

NON-LINEARITY: percent deviation of full-scale output from best-fit straight line. The Type C establishes the linearity by giving force or pressure readings in percent of full scale at any number of physical loads. And since the reading is always in percent of full-scale, the tedious arithmetic of other methods is eliminated.

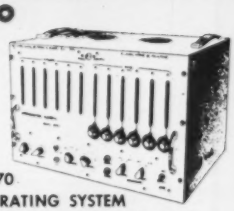
SENSITIVITY: expressed as lbs. per ohm, mv. per volt, etc. This factor often changes, especially when the transducer has been subjected to vibration and overloads. The Type C quickly reveals a sensitivity change by its "electrical equivalent" check.

CREEP: a change in electrical output caused by plastic deformation within the transducer, in the absence of changing load. This fault is quantitatively revealed by the Type C.

DRIFT: a change in electrical output caused by temperature gradients, voltage leakage, etc. This fault is quickly detected by the Type C if it is an intrinsic characteristic of the transducer.

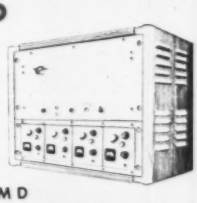
These and other measurements are quickly (and most important, accurately) provided by the Type C, with semi-skilled operators. Assure yourself of accurate force and pressure measurements. Write for detailed literature on the Type C and for your copy of the ALINCO report "Wire Strain Transducer System Calibration."

ALINCO



270
INTEGRATING SYSTEM
instantly displays time and integral

ALINCO



SYSTEM D
galvanometer amplification system

ALINCO

K-7
ERROR COMPUTOR
gives magnitude and location of transducer system error

ALINCO

Allegany Instrument Co. Inc.

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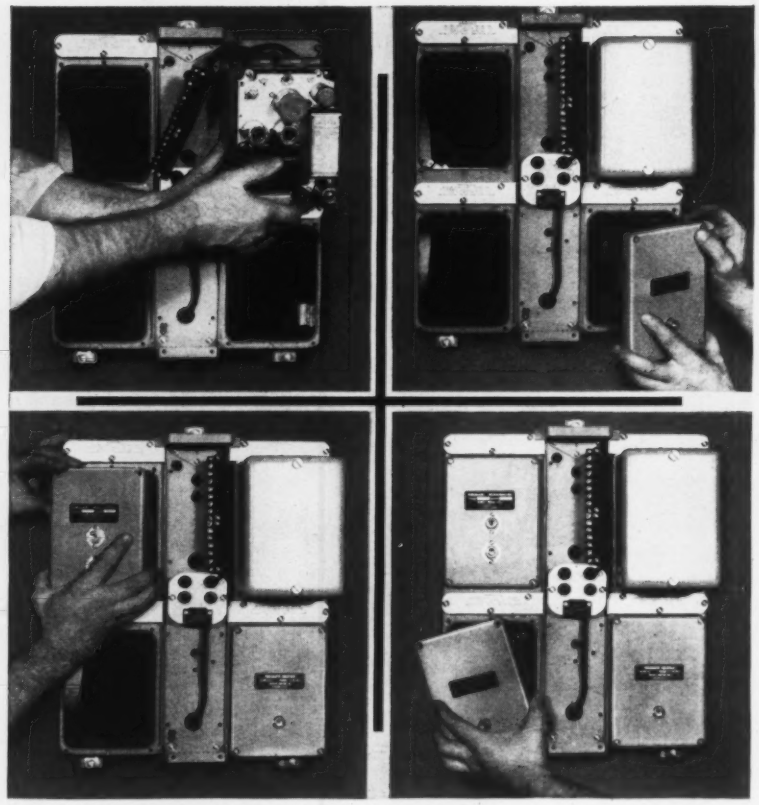
WESTERN DIVISION: 1052 West 6th Street Los Angeles 17, Cal.

For more information circle **46** on inquiry card.

CUSTOM BUILD your own Bailey Recorder



These four views of the back of a Bailey Recorder show how four plug-in units may be added as needed to meet almost any recorder application.

The freedom and flexibility of "do-it-yourself" instrumentation is yours in the Bailey Recorder. A variety of plug-in units make it possible to record, control, and retransmit any variable that can be converted to a pneumatic or electric signal.

The basic plug-in units are the Bailey a-c and d-c Electronic Receivers and Pneumatic Receivers. Any four of these may be used in one recorder, intermixed in any way, to provide four continuous records on one chart.

For automatic control, other plug-in units are available.

For square root extraction or linear integration, there are two plug-in variations of the Bailey Integrator.

When you want a pneumatic signal that varies according to a pre-set pattern plug in a Bailey Program Controller.

Periodic running time of a condition or process is recorded on the chart when a Bailey Running Time Recorder is used.

These and other plug-in units are described in Product Specification E12-5. Some companies stock Bailey Recorder cases and assorted plug-in units. As instrumentation and control needs arise they build up the kind of recorder-controller required, using the proper plug-in units from stock. Unmatched versatility such as this means lower instrumentation costs.

For the complete story of how easily you can custom build this recorder to your needs, see your Bailey Engineer. G43-1

BAILEY METERS

Instruments and controls for power and process

BAILEY METER COMPANY

1041 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

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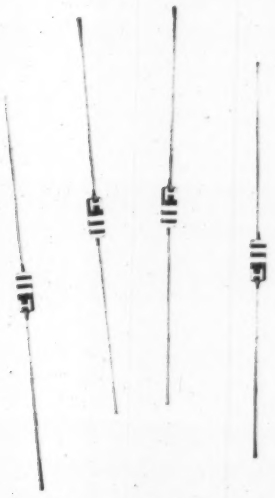

Hughes
Quick Recovery
Silicon
Junction
Diodes

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...and able to withstand high voltages at high temperatures, these quick recovery silicons are particularly useful in circuits where germanium once provided the only possibility. Unlike germanium, breakdown voltages for the silicons *increase* with temperature, thereby removing the danger of failure should temperatures rise to unexpected levels. This kind of ruggedness together with increased speed identify the diodes as ideal when the demand for reliability is greatest.

Perhaps one of the IN620 series will be just right for your particular application; if not, there will undoubtedly be a Hughes germanium or silicon diode that is. For a call from one of our field sales engineers or for additional information about our quick recovery silicon diodes, please write:

SPECIFICATIONS	
WIV @ 0.1mA	up to 200V
Forward Voltage @ 4mA	less than 1.5V
Recovery (modified IBM "Y" test)	400K ohms (min.) in one μsec. when switched from 30mA forward to −35V reverse.
Reverse Current @ 25°C	as low as 1μA @ −175V
Reverse Current @ 100°C	as low as 100μA @ −175V
Operating Temperature Range	−80°C to +150°C

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PHYSICAL CONFIGURATION. All types are packaged in the famous glass body, created at Hughes to provide absolute protection from moisture penetration and contamination. Body length: 0.265 inch maximum. Body diameter: 0.105 inch maximum.

SEMICONDUCTOR DIVISION • HUGHES PRODUCTS *International Airport Station, Los Angeles 45, California*

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HUGHES SEMICONDUCTORS

HUGHES PRODUCTS

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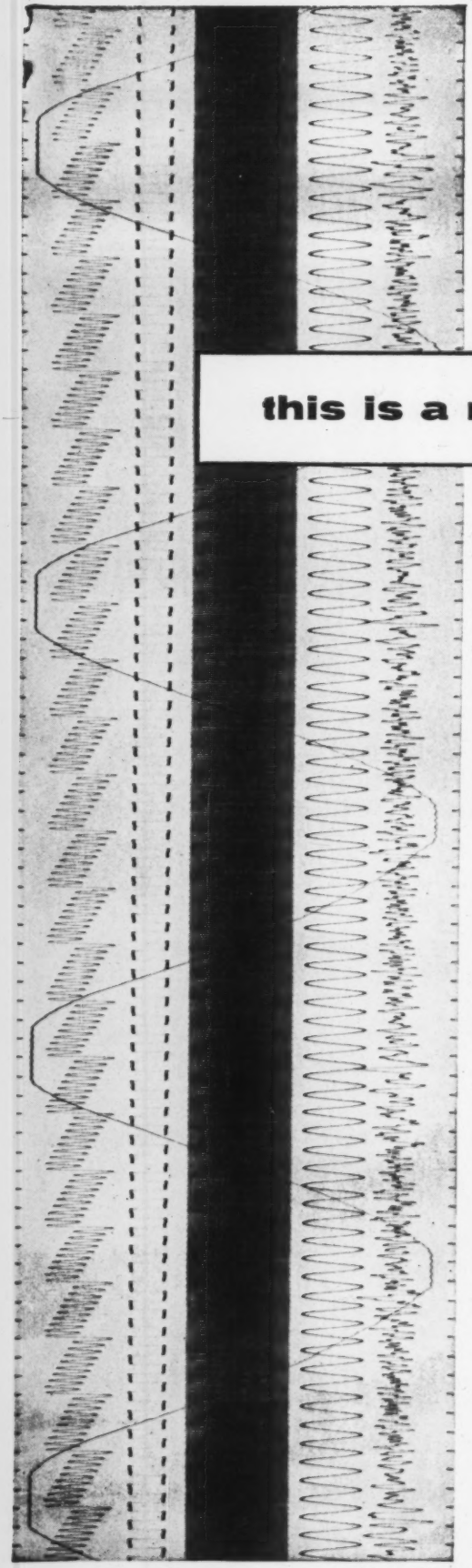
For more information circle **48** on inquiry card.



this is a record of leadership

This Visicorder Oscillograph record* is a symbol of the leadership that is typical of Honeywell engineering. In laboratories all over the world the Visicorder's instantly-readable direct records are showing the way to new advances in rocketry, control, computing, product design and component test, and in nuclear research.

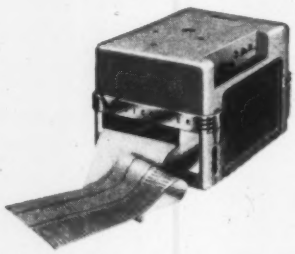
The Model 906 Visicorder is years ahead of the trend. It is the first recording oscillograph that combines the convenience of direct recording with the high frequencies and sensitivities of photographic-type instruments. The Visicorder alone among oscillographs makes it possible for you to monitor high-speed variables as they go on the record.

To record directly the high frequency variables you need to study, use the Visicorder Oscillograph. Call your nearest Minneapolis-Honeywell Industrial Sales Office for demonstation.

*reproduced half size

Minneapolis-Honeywell Regulator Co., Heiland Division, 5200 East Evans Avenue, Denver 22, Colorado.

Reference Data: Write for Visicorder Bulletin



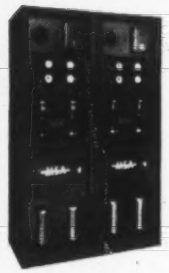
MINNEAPOLIS
Honeywell

Heiland Division

For more information circle **49** on inquiry card.

Low-cost deflection type unit for automatic, continuous, high speed, accurate analysis. Detects one component in a simple or complex mixture of gases or liquids. Unitized construction makes maintenance easy. All controls readily accessible on front panel. Write for details.

M-S-A (LIRA) Infrared Analyzer (Model 200)

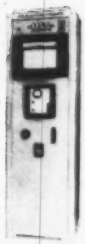


Single or multipoint cabinets designed as alarms or recorders are available for detecting or measuring low concentrations of carbon monoxide in air. Measurements are based upon measurement of heat of oxidation when sample is drawn through granular catalyst. Write for details.

M-S-A Carbon Monoxide Analyzer

Adaptable for use with any gas or vapor of which the explosive range, and molecular weight are known. Applications extend to all industries where combustible fluids are employed. Now available with remote filament heads specifically adapted to high temperature applications. Write for details.

M-S-A Combustible Gas Analyzer

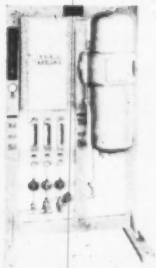


Simultaneously uses thermal conduction and thermal convection to provide simple, accurate, physical measurement of a single component in a complex mixture of gases without interference from other constituents. Can be used in many gas mixtures. Write for details.

M-S-A Gas Thermatron

For precise, continuous measurement of oxygen content of inert and combustible atmospheres in chemical, metallurgical and petroleum industries. Provides means for improving safety of utility operations and controlling pipeline corrosion. Write for details.

M-S-A Oxygen Indicator



Detects trace moisture in air or gas streams. Operation is based on measurement of the heat energy exchanged when a gas is adsorbed on or desorbed from the surface of a solid adsorbent. Can be calibrated for various ranges from 0 to 10 parts per million up to several percent. Write for details.

M-S-A Water Vapor Recorder

This line-up of M-S-A® Gas Analyzers can help solve your process stream problems

M-S-A Gas Analyzers have earned a sound reputation for on-stream accuracy and dependability while solving a myriad of complex control problems. Chances are, some of the problems confronting you now have already been solved for others, with one of the basic units described above.

The experience and service we can bring into play may provide the breakthrough you're looking for in successful process stream control. Our thirty years in the business of gas analysis instrumentation are worthy of your consideration. Get in touch with an MSA Instrument Specialist for details, or write for helpful literature.

MSA

INSTRUMENT DIVISION

MINE SAFETY APPLIANCES COMPANY

Pittsburgh 8, Pennsylvania

At your service: 76 Branch Offices in the United States

For more information circle **50** on inquiry card.

For the record...

it's IMMEDIATE-PRINT scope photos with the DU MONT® 302

- NOW, ULTRA-FAST TRANSPARENT POLAROID-LAND FILM FOR HIGH SPEED RECORDING!
- CONTACT AND PROJECTION PRINTS... NO IMAGE REVERSAL.
- EASY, INEXPENSIVE CONVERSION TO VARIETY OF STANDARD ROLL AND CUT FILMS.
- CLICK-STOP SLIDE PERMITS MULTIPLE EXPOSURES ON SINGLE FRAME FOR GREATER FILM ECONOMY AND EASY, DIRECT WAVEFORM COMPARISON.
- FULL BINOCULAR VIEWING SIMULTANEOUS WITH RECORDING.
- MOUNTS QUICKLY AND EASILY ON ANY STANDARD 5" SCOPE. NO ADDITIONAL SUPPORTS REQUIRED.
- EASY ACCESS FOR LENS AND SHUTTER ADJUSTMENT.
- BUILT-IN DATA RECORDING SYSTEM.

SPECIFICATIONS

- Wollensak-Du Mont 75 mm f/2.8 three element lens, or 75 mm f/1.9 six element lens.
- Image reduction ratio 2.25:1.
- Alphax #2 shutter, bulb and 1/25 to 1/100 sec. with f/2.8 lens. Alphax #3 shutter, time, bulb and 1 sec. with f/1.9 lens.
- Writing rate dependent upon film used.
- Mounting clamp for use on any standard 5" scope bezel.

Type 302 with f/2.8 lens **$314.00**
Type 302 with f/1.9 lens **391.00**

The Du Mont Type 302 Recording Camera provides the most convenient and flexible means for applying the many advantages of the immediate-print Polaroid-Land process to oscilloscope recording.

And now the utility of the Polaroid-Land process has been greatly extended with the development of the new Polaroid-Land projection film — a transparent base material with a specified **emulsion speed of 1000** (ASA).

This new film not only permits contact and projection prints, and eliminates image reversal, but also enables use of the Polaroid-Land process in recording ultra-high-speed phenomena — even single transients.

Utility of the 302 is further broadened by the availability of adapter backs which permit the camera to use various standard roll and cut films. **Write for full information...**

WHATEVER YOUR REQUIREMENTS... DU MONT HAS THE CAMERA

TYPE 352

High-speed, single frame 35 mm featuring automatic film advance. 8 frames/sec. automatically. Wollensak f/1.5 lens. **$648.00**

TYPE 339

Immediate-print type utilizing Polaroid film. Special f/2.8 lens for distortion-free images. Binocular viewing of screen. **$246.00**

TYPE 299

General-purpose camera accepting backs for roll-film, film-pack, or cut film. Converts to Type 302 for Polaroid recording. f/1.9 lens **$369.00**, f/2.8 lens **$292.00**

TYPE 296

Low-cost, general-purpose single-frame camera. Uses standard casette wound 35 mm film. Corrected f/2.8 lens. Viewing port. **$164.50**

TYPE 321-A

Permits either continuous or single-frame recording. Perforated or unperforated film or paper in 100 or 400 foot reels. Variable film drive speeds from 0.8 to 10,800 in./min. 321-A with f/1.5 lens **$1270.00**, 321-A with f/2.8 lens **$1120.00.** (50 cps models available)

DU MONT®

WRITE FOR COMPLETE DETAILS...
TECHNICAL SALES DEPARTMENT, ALLEN B. DU MONT LABORATORIES, INC.
CLIFTON, NEW JERSEY

For more information circle **51** on inquiry card.

Staff Scientist Dr. J. W. Muehlner (center) discusses an advanced PDM telemetering system for missile application with K. T. Larkin (left), Telecommunications Department manager, and J. R. Dawley, Telecommunications Systems Section head.

New positions in

MISSILE SYSTEMS TELECOMMUNICATIONS

Weapon systems programs at Lockheed Missile Systems demand advances far exceeding the current state of telecommunications. Positions are open on the Palo Alto, Sunnyvale and Van Nuys staffs for scientists and engineers possessing a high level of ability and interest in:

TELEMETRY – Research in various areas of physics and electronics related to advanced telemetering projects; theoretical analysis of advanced FM, PDM, PCM System concepts; design integration of all phases of telemetry with weapon systems requirements; conception and development of original high-capacity and high-accuracy systems; development and package design of airborne telemetering equipment capable of operating under extreme environmental conditions, including transducers, subminiaturized subcarrier oscillators, crystal controlled FM transmitters, solid state commutators, PDM keyers, digital storage and conversion devices; development and prototype design of ground telemetry equipment to include devices such as high-efficiency decommutators, calibrators, digital encoders.

COMMUNICATIONS – Application of information theory concepts to challenging communication link problems; analysis and design of microwave communication link components to be utilized in most advanced weapon systems; development and test of television links for special projects.

Address the Research and Development Staff at Palo Alto 1, or Van Nuys 34, California.

Lockheed

MISSILE SYSTEMS

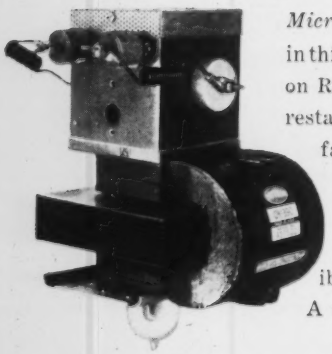
A DIVISION OF LOCKHEED AIRCRAFT CORPORATION

PALO ALTO • SUNNYVALE • VAN NUYS

CALIFORNIA

Microwave cooking shaves hours from food preparation time. This is a home-type electronic oven developed by Raytheon for production by appliance manufacturers.

Meals in minutes by electronics– in permanent magnet equipped range



Permanent magnet is C-shaped casting at right of magnetron; box on top is filter assembly.

Microwave energy does the cooking in this domestic electronic oven based on Raytheon's "Radarange" for the restaurant industry. Microwaves are far higher in frequency than broadcast waves–fact, the magnetron tube (at left) steps up the vibrations to an incredible 2,450,000,000 times a second! A vital part of the magnetron is the Crucible Alnico permanent magnet shown in the inset.

This is one of many practical applications for Crucible Alnico permanent magnets. Crucible has been a leading producer of permanent magnets, known for their *consistently higher* energy product, ever since Alnico alloys were developed. You can now order them sand cast, shell molded, or investment cast to every size, shape, or tolerance needed.

It's why an increasing number of manufacturers find the answer to their magnet problem at Crucible. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

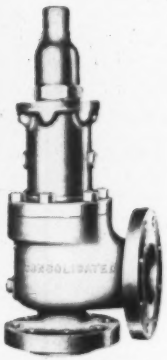
CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

For more information circle **52** on inquiry card.

WHAT YOU DON'T SEE

MEANS THE MOST



...in service

...in economy

...in protection

Few Functional Parts. Each part is precision machined and aligned to assure long valve life and minimum maintenance.

Economical "2 in 1" Design. Construction that permits you to convert the Standard valve to the Bellows type *in your own shop.*

Only One Adjusting Ring. Easy to set *before* the valve is installed to obtain peak performance at 4-5% blowdown. Whatever the ring position, *full relieving capacity is certain* because a fixed maximum secondary orifice provides full lift at 10% over-pressure. Even with "superimposed" back pressure in the relieving system, *valve action is consistently positive.*

Temperature-Compensating Disc. Temperature-induced stresses cannot distort the seat. Seating is always tight, even when nominal strains of unanchored discharge piping are present. Minimum guiding area is provided to align the seating surfaces – less chance of a sticking disc holder when corrosion or contamination build up on the guiding surfaces. The seating surfaces are optically-ground flat – servicing is easier, highly economical.

Huddling Chamber and Secondary Orifice Contours take full advantage of the stream pressure and kinetic forces – an exclusive safety feature.

Low-Placed Threaded Section Holds Nozzle in Valve. Assures high resistance to discharge of piping strains. No leakage from strain induced into the nozzle.

Standardized Inlet-Outlet Face-To-Face Dimensions permit easy interchangeability with the valves of some other manufacturers.

Certified and Approved. Both Standard and Bellows Valves – in the full range of sizes and pressures – are approved under ASME Unfired Pressure Vessel Codes and are certified by the National Board of Boiler and Pressure Vessel Inspectors.

Absolute protection for personnel and facilities . . . far fewer inventory and maintenance needs . . . long-term economy. Be assured on every count before you buy another safety relief valve. Investigate fully the quality of Consolidated Safety Relief Valves—then compare. *Write for Catalog 1900.*

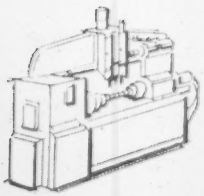
In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario.*

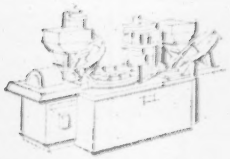
CONSOLIDATED SAFETY RELIEF VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** TULSA, OKLAHOMA

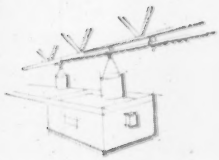
MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Okla.* AIRCRAFT CONTROL PRODUCTS, *Danbury, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

For more information circle **53** on inquiry card.

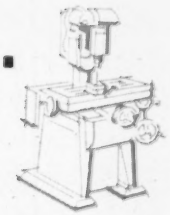


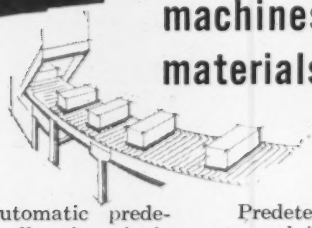


NEW ELECTRIC PREDETERMINING COUNTER...



for remote operation of machines, processes, materials handling





This Veeder-Root automatic predetermining control device offers, in a single unit, new convenience and flexibility in the solution of machine and process control and materials handling problems. Five readily set control knobs provide great ease in establishing any of the 100,000 possible control points. The electromagnetic counting unit permits the use of a wide variety of remote actuators, switches, contactors, electric eyes, or other sensing units. This provision, in conjunction with the several possible electrical control circuits, allows completely remote operation of the controlled equipment.

Predetermining control units can be grouped in a single central location for convenient setting of the predetermined quantities and visual monitoring of the accumulated counts. Additional ease of operation is afforded by the two-second duration electric reset which allows completely automatic recycling, automatic reset in preparation for the following cycle, or push button reset whenever desired. For full details, write:

VEEDER-ROOT INC.

HARTFORD 2, CONNECTICUT

Hartford, Conn. • Greenville, S.C. • Altoona, Pa. • Chicago
New York • Los Angeles • San Francisco • Montreal
Offices and Agents in Principal Cities

Everyone can count on

VEEDER-ROOT

For more information circle **54** on inquiry card.

Book Reviews

Control Valves, by Chester S. Beard, edited by Fred M. Marton (C 1957) Instruments Publishing Co., 845 Ridge Ave., Pittsburgh 12, Pa. 230 p. $2.00. Completely up-to-date reference volume. Covers recent developments such as d-c, electrohydraulic and gas-hydraulic actuators and new positioners. Numerous illustrations and tables. A "must" for all technical libraries, companies in process industries, contractors of industrial plants, instrument technicians, and students.

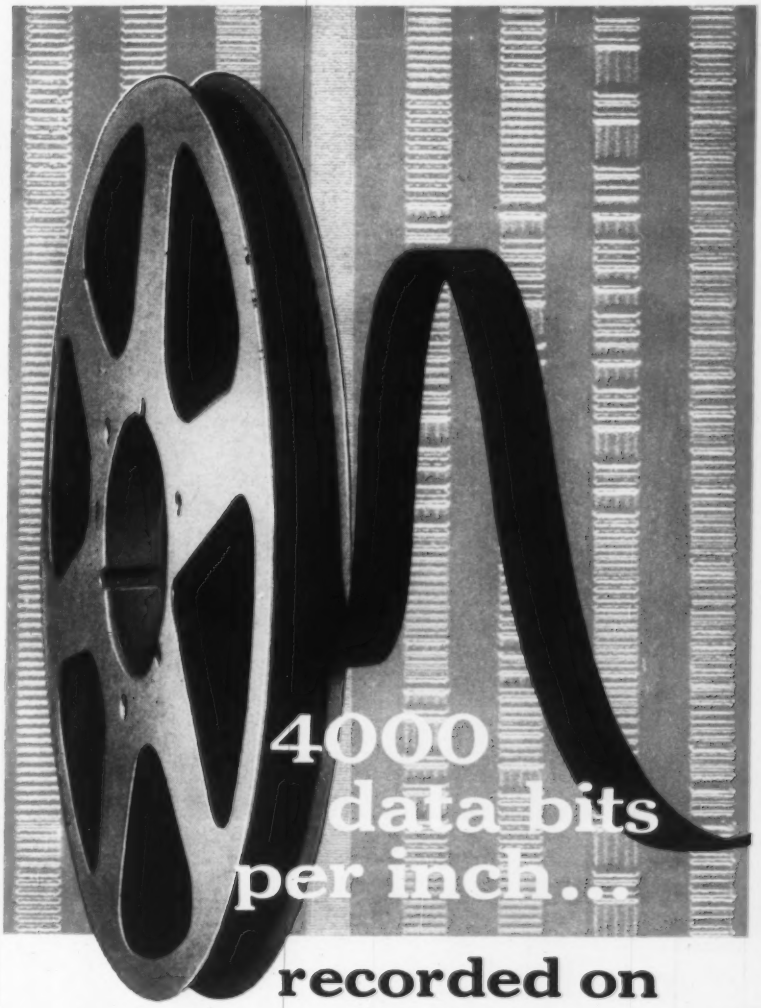
Project Engineering of Process Plants, by Howard F. Rase and M. H. Barrow. [c1957.] John Wiley & Sons, New York 16, N. Y. 692 p. $14.25. 9¼ in. Said to be the first book to recognize the new profession of the "project engineer" and the first book "written in accordance with modern techniques" on design of plants. Includes some technical and some very elementary material.

Pulse and Digital Circuits, by Jacob Millman and Herbert Taub. 1956. McGraw-Hill Book Co., New York 36, N. Y. 687 p. $12.50. 9¼ in. Much of the earlier work on Electronics was concerned with radio communication. The present book deals with techniques which have no counterpart in radio engineering.

Wave Propagation, edited by Alexander Shure. [c1957.] John F. Rider, New York 11, N. Y. 56 p., unbound. $1.25. 8½ in. Brief treatment of the nature of electromagnetic waves and the fundamentals of wave propagation. Discusses wave reflection and refraction, normal tropospheric propagation and scatter propagation.

Digital Differential Analyzers, by George F. Forbes, c1956. Author, Pacoima, Calif. [182p.], unbound. $7.50. 11 in. A manual of applications for digital and Bush types analyzers. Gives details of operation only to clarify the application. Mathematical treatment. Includes a glossary and a brief bibliography. Reproduced from typewritten copy.

Microphotograph of pulse recording on Soundcraft Instrumentation Tape



recorded on

SOUNDCRAFT type "A" INSTRUMENTATION TAPE

and played back without error!

In the new Rocketdyne IDIOT* II computer system, 4000 data bits (over 500 bits of information per channel, per linear inch) have been stored in an inch of Soundcraft Type "A" Instrumentation Tape... double the amount of information that has been stored in equivalent lengths of competitive tapes! What made the difference? Soundcraft Type "A" Tape ... the only tape engineered specifically for pulse recording. Its special RCCH oxide formulation provides an extremely hard surface with high thermal softening point — prevents imbedding of foreign particles. The formulation is uniformly applied to the durable Mylar† base by patented Uni-level process; then Micropolished to remove surface irregularities. These exclusive design features assure you of error-free pulse recording with Soundcraft Type "A" Instrumentation Tape. Write for Soundcraft Type "A" Instrumentation Tape Brochure.

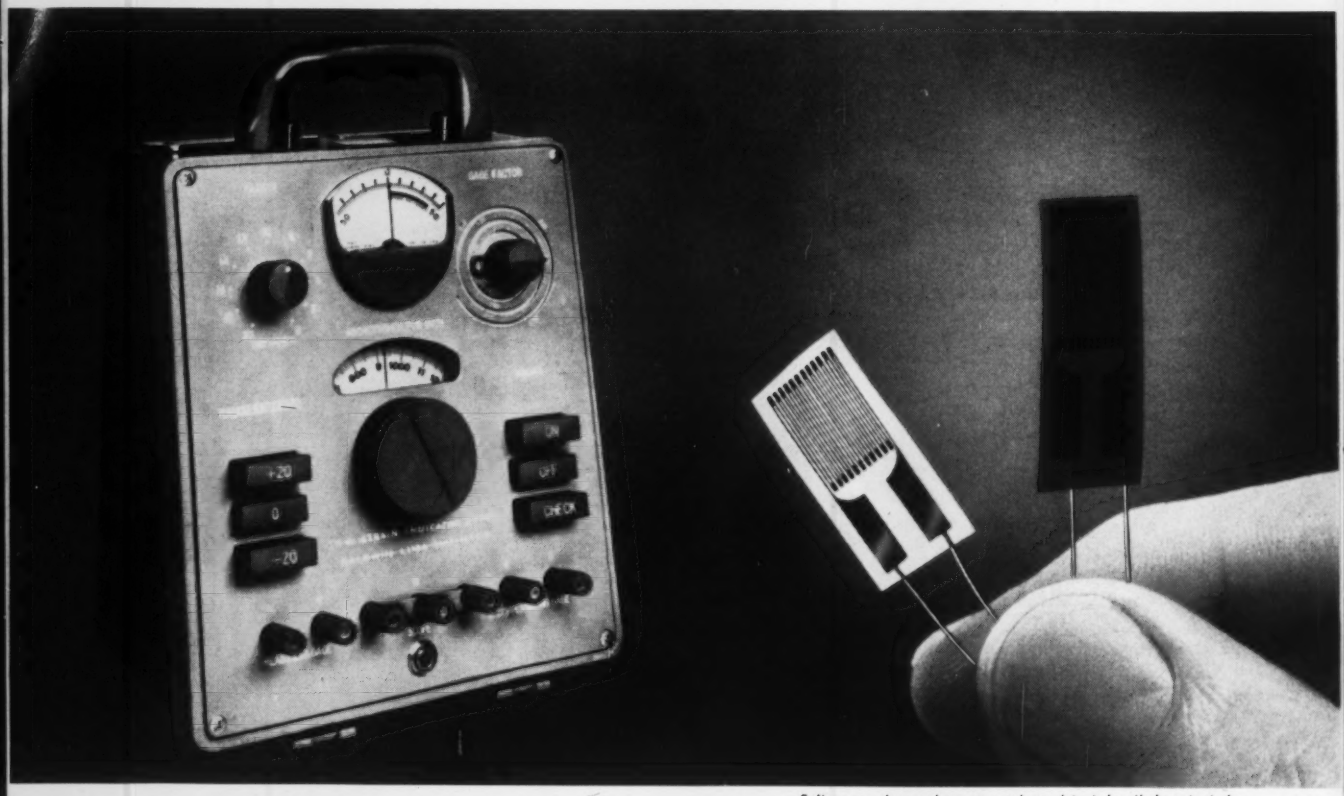
*Rocketdyne Instrumentation Digital On-Line Transcriber. †Dupont T. M.

REEVES SOUNDCRAFT CORP.

10 E. 52nd St., N. Y. 22 • West Coast: 338 N. La Brea, L. A. 36, Calif.

For more information circle 55 on inquiry card.

Newest strain-measuring equipment from Baldwin



Foil gages shown above are enlarged to twice their actual size.

NEW SR-4® strain indicator and NEW SR-4 bonded foil strain gages

Type N SR-4 Strain Indicator

This new, improved strain indicator features printed circuits and transistors, weighs one-third less than the previous model and has a smaller case. No warmup is required. In intermittent service its batteries last up to five times as long and cost two-thirds less. The legs of the case are positioned to permit tilting for improved readability. For direct readings with full external bridge, no calibration correction is required. Used as a preamplifier with standard cathode ray oscilloscope, it gives visual indication of dynamic strain with better response and in a broader range than the previous model. Frequencies up to 300 cps at amplitudes up to 3500 microinches per in. can be observed without appreciable distortion.

SR-4 Bonded Foil Strain Gages

Two new types of foil gage in ½ in. gage length, 120 ohms resistance, now make many types of stress analysis possible with new accuracy and ease. A Bakelite-bonded gage, Type FAB-2, and a quick-drying paper-and-cement-bonded gage, Type FAP-2, have marked advantages over comparable standard bonded wire strain gages. Hysteresis is now so low as to be negligible for stress analysis. Fatigue life of the paper gage matches that of comparable wire gages—that of the Bakelite gage is longer. Lateral strain sensitivity of both is down by one-half, offering new accuracy in measuring biaxial strains. The quick-drying paper gage is quick and easy to install. The Bakelite gage offers such attractive features as dependable service at 300°F or higher. It is thinner and more flexible than comparable bonded wire gages—requires no preforming for curved surfaces and is thus easier to apply. Its glass fiber filler makes it less sensitive to moisture effects.

Both new foil gages have tinned lead wires, well anchored and easy to connect. Both gages are now stock items for prompt delivery. For more information on this or other Baldwin stress analysis equipment, write to Electronics & Instrumentation Division of B-L-H, Waltham, Mass. Or we will have a representative call on you at your request.

BALDWIN · LIMA · HAMILTON

Electronics & Instrumentation Division

Waltham, Mass.

SR-4® strain gages • Transducers • Testing machines

For more information circle **56** on inquiry card.

INSTRUMENTS and AUTOMATION

AUTOMATION: The use of devices—mechanical, pneumatic, hydraulic, electrical and electronic—for making automatic decisions and efforts.—*M. H. Aronson*, Editor

Editorial

Automation and Small Business

H. F. DEVER, President, Brown Instruments Div., Minneapolis-Honeywell Regulator Co.

TODAY there still is a substantial "semantic curtain" between the scientists and the engineers on the one hand and the ultimate users—the businessmen—on the other.

I'll not regale you with tales of automatic factories requiring no labor force, of machines with superhuman characteristics and electronic "nervous systems" or Buck Rogers' robots, however fascinating they may be. Instead I'd like to discuss one phase of this thing called automation—Instrumentation. And I'd like to let my comments on the instrument phases of automation be based on the understanding that this whole activity is merely an extension of the process of making things automatic that has been going on for many years! This form of automation is not new.

For every multi-million-dollar electromechanical machine, for every new, man-made "brain" development that threatens to obsolete even pushbutton devices, there are literally hundreds of more prosaic, less expensive, off-the-shelf automatic instruments that daily function as the "sinews" of this trend toward factory or process automation.

The products of our particular industry, as many of you are well aware, are mechanical, electric and electronic devices that indicate, record and control a variety of physical and chemical conditions vital to production, including temperature, pressure, etc.

There are many "typical" applications, and there can be and are many custom-engineered applications —each differing from the next. As to the products, they may range from thermostats or millivoltmeters costing, say, $50 to $200, to elaborate electronic recorder-controllers costing $2500 to $3000. A single unit may serve some purposes adequately, but, in others, complete integrated control systems are needed to harness large numbers of instruments of a wide variety, and such systems may cost from $100,000 to $500,000.

The major advantages of instrumentation are, of course, economic. Let me cite a few specific examples:

Abstracts of a talk presented before the Metal Manufacturers Association of Philadelphia

Brick Company, Macon, Georgia

Installation of continuous kilns with automatic control increased production and quality. Temperature controls alone upped brick production 10 percent. Approximate cost of temperature controls: $5,000.

Textile Mill, Startex, S. C.

The addition of one slasher cylinder plus automatic controls on a textile slasher increased slasher production 50 percent. Approximate cost of controls: $2,000.

Office Building, Omaha, Nebraska

Installation of a single instrument plus switches and measuring elements enabled one man to read temperatures in 144 different locations throughout a 5-story-and-basement office building. System paid for itself in two years. Approximate cost: $6,000.

Cooperative Farmers Dairy, Allentown, Pa.

Automatically controlled pasteurizing equipment at this dairy upped production from 3,400 pounds of milk per hour to 100,000 pounds per hour. Approximate cost of automatic controls: $4,000.

Manufacturing Company, Dayton, Ohio

Installation of automatic temperature controls on plastic molding presses reduced rejects 38 percent. Approximate cost of controls for each press: $1,000.

Iron & Steel Company, Pueblo, Colo.

The modernization of 40-year-old soaking pits (7 rows and 28 holes), including the addition of automatic controls, increased the yield $14,000 annually, cut fuel rate 25 percent, lengthened pit life 50 percent, cut daily bottom making from 1½ hour to ¼ hour. Approximate cost of automatic controls: $100,000.

Steel Company, Pennsylvania

Automatic control systems installed on 8 open-hearth furnaces almost paid for themselves in their

EDITORIAL—continued

first year. Approximate cost of all 8 control systems: $75,000.

These illustrations are by no means exceptional. Similar case histories could be cited for more firms and the full potential of automatic control is still very far from being realized. We are still only some 10 to 15 percent along the way to realizing its full potential.

You don't need two or three million dollars for plant and equipment purchases to get your feet wet in automation. Much automation—more, probably, than many of you realize—can be bought at conventional equipment costs.

Most of our smaller businesses would appear to be at a disadvantage as compared with the industrial giants when it comes to things other than automation. It is not to be expected that our small companies can necessarily match the giants in research staffs, in advertising, in elaborate personnel activities—yet they can and do compete.

The small company, with lower overhead, greater flexibility, more direct supervision, can capitalize on the production-restricting factors affecting its larger contemporaries and protect—and even expand—its own business right under the gun, so to speak.

Now you might logically ask, "How does a firm go about automation. How can we take advantage of it?"

I suggest that you visit plants in comparable industries; use consultants; apply incentives within your organization for improved methods work; get together with the qualified manufacturers—they can help you select the proper equipment; do not overlook the better magazine and trade publication articles and text books on the subject, and finally, your trade associations may be of help.

Let me caution you heads of businesses, however, that the handling of the program of automation cannot be delegated completely to someone else on the assumption that it is simply a matter of technology. The important ponderables are precisely those that the owners or directors and top management have always held in their own hands; you heads of businesses determine the position of your company in its own industry; you make the decisions on diversification versus concentration; you decide the development and use of corporate cash and credit resources; you set the methods for the handling of depreciation and taxes (with Uncle Sam's help, that is): and from these come the decision as to the character of personnel the company's future requires. And you will set the pattern of automation for your company.

Do you recall three statements widely heard at the end of World War II: inevitability of a postwar depression, the softness of today's executives who do not remember bad times, and the possibility that machines would replace men?

Companies that charted intelligently the extent of war-deferred needs and adopted the potentials of war-developed technology have really gone to town. Today's young executives are providing a quality of competition that is not soft. And virtually every industry that has increased its investment per employee has also increased its employment; steel, automotive, telephone, mining, chemicals—all bear evidence of this. Thus the history of the country's rising standard of living coming from our remarkably productive, risk-taking system leads to the inevitable conclusion that automotion, far from being a threat, is another essential to the nation's future progress.

A year or so ago, automation was raised by the labor unions as a bogeyman threatening not only man's dignity but his very existence. I thought then, and still do now, that the alarms were being sounded as a bargaining tool. Even the Congress had an investigation and, after hearing many people, it saw no reason to fear for the welfare of American labor to the extent of recommending any special legislation at all. Since then the more emotional aspects of automation have been heard of less and less.

Automation is worthy of your time and study right now. It is a complicated technical subject but it can be a realistic, progressive and constructive force in your business or industry right now also. It is a subject—and includes a program—that alert management can use to advantage, beginning now.

Dear D.R.*:

Hope this September issue finds you nicely tanned and rested up, and ready for an exciting wind-up to an interesting year of instrument developments.

Looking ahead, we bring you two exciting economic analyses this month—one on the electronics market (now the nation's *5th largest market*) and one on the exploding transistor market.

We think you will like the story on "Instrumentation in Medical Education" because it shows how one school is revising century-old instrumentation to modern needs. Here's a tip: watch for some exciting news in the field of Medical Electronics—from Instruments Publishing Company.

Have you ever wondered what the orders of magnitude were for the errors introduced by using several thermocouples in parallel? Paul Kilpatrick did, and he tells you exactly what they are on pages 1706-1709.

Perhaps a more general problem is that of controlling a plant with pure time delay, one of the toughest unsolved problems in the process-control field. So pay particular attention to the article "Controlling the Pure-Delay Plant" on pages 1720-1722.

The articles "Level Regulators" and "Recording Potentiometers" are aimed at process men, and the article "Multiple-Address Magnetic-Tape Transport is directed to all you with an interest in data handling—as is Panhandle Pete's classic this month.

Of course there are many other features in these 200-plus pages, which we hope find you (reading) well and happy this month.

Cordially
Milt and the Editors

*Dear Reader

Introducing Number **1** *of a Factual Series about the Hughes* MEMO-SCOPE* *Oscilloscope*

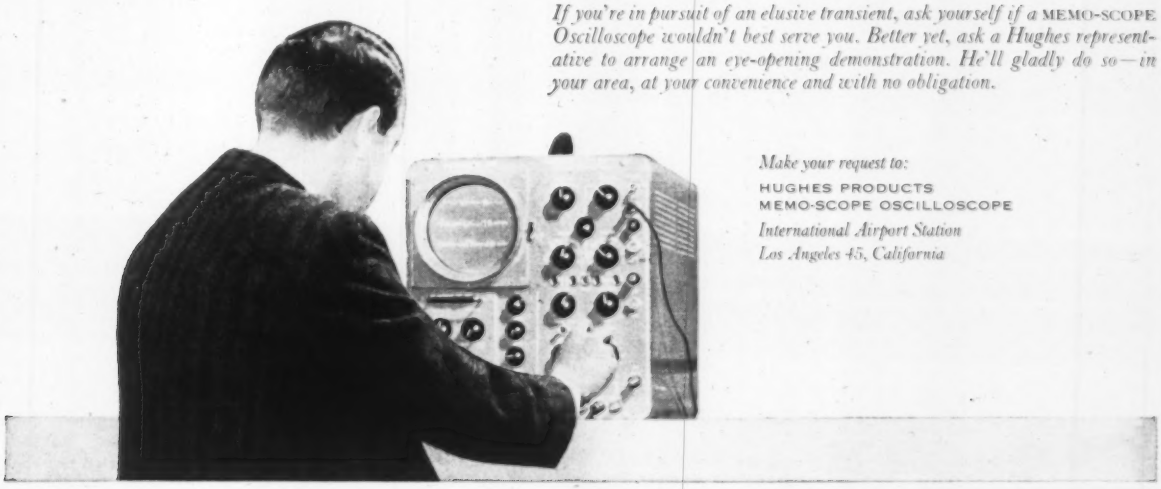
MAN-DAYS SAVED

in research and testing involving transients

We are pleased to report a major breakthrough by a Hughes product that will significantly reduce the monotonous man-days spent pursuing elusive transients. Practically a promise of all things to all men in research and testing procedures involving traces, this new instrument of benefaction is the Hughes MEMO-SCOPE* Storage-Type Oscilloscope. A transient recorder with a "memory" it can retain single or successive writings for an *infinite length of time or until intentionally erased.*

Heretofore, the tedious trial and error methods and repetitious hair-trigger photography necessary to "capture" transients on conventional scopes has mercilessly wasted time, film and precious effort, not to mention ruffling dispositions. But, never again. Now, you may instantly "freeze" any number of selected wave forms in brilliant clarity on the face of a MEMO-SCOPE Oscilloscope —study, compare and analyze them at leisure. Or if desired, take convenient photographs with just one camera setting—one exposure—for each permanent record required. Superbly engineered and completely electronic, MEMO-SCOPE Oscilloscope involves no slide wires, no bothersome paper and ink problems.

If you're in pursuit of an elusive transient, ask yourself if a MEMO-SCOPE *Oscilloscope wouldn't best serve you. Better yet, ask a Hughes representative to arrange an eye-opening demonstration. He'll gladly do so—in your area, at your convenience and with no obligation.*



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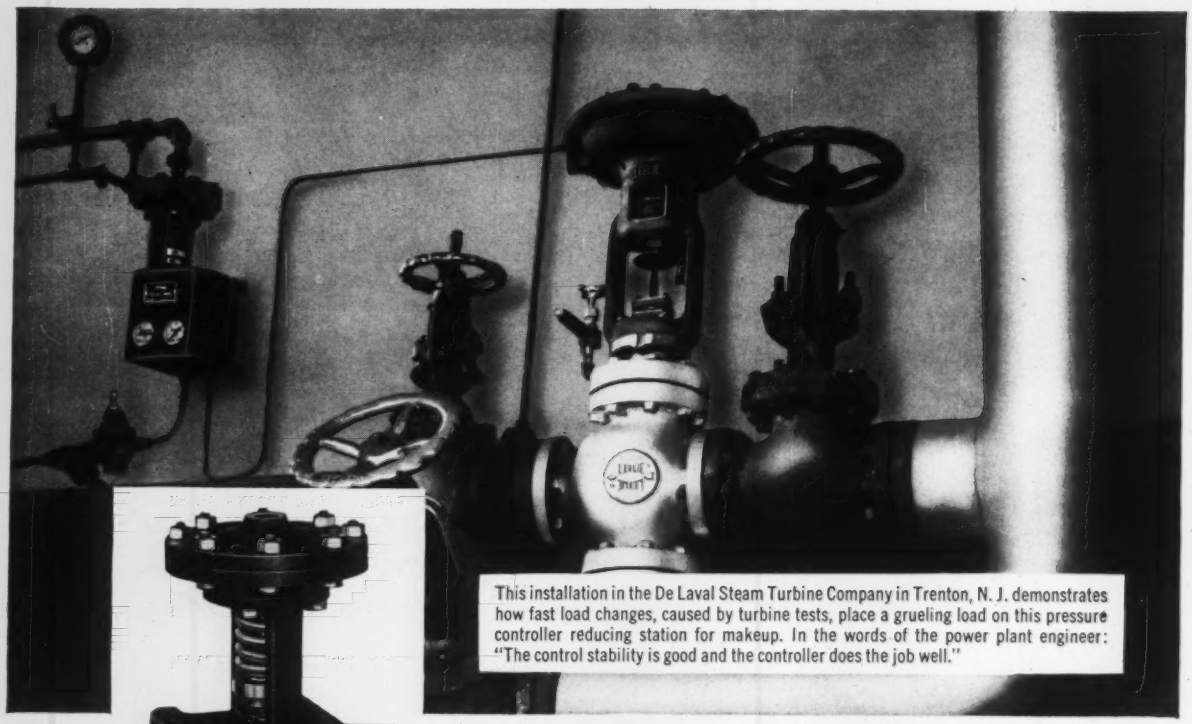
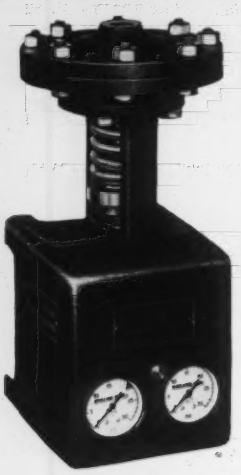


This installation in the De Laval Steam Turbine Company in Trenton, N. J. demonstrates how fast load changes, caused by turbine tests, place a grueling load on this pressure controller reducing station for makeup. In the words of the power plant engineer: "The control stability is good and the controller does the job well."



Leslie Pressure Pilot

Narrow Band Pressure Control *with Stability*

Wide band stability and narrow band proportional control are uniquely combined in the Leslie Control Pilot without need for extra mechanisms to correct for over-sensitivity.

While the pilot responds to small, *definite* pressure changes, it "sorts out" and "ignores" the small, spurious* disturbances common to most control systems. Since it does not follow nor magnify these disturbances, cycling and hunting are eliminated. It is ideal for systems with short lag factors.

*not directly related to process variables but resulting from pipeline friction and turbulence.

NO COSTLY EXTRAS

The "designed-in" stability and high capacity of Leslie Pressure Control Pilots also eliminates costly "extras" . . . there is no need for automatic reset, valve positioners or filter-type air sets. You get stable, reliable control *without* fussy adjustments and with *ordinary* plant air or water for the operating medium.

Send for Bulletin 5303 that gives complete technical data and typical application sketches for the Leslie Pressure Control Pilot.

MORE INFORMATION

Ask your Leslie engineer to give you the complete story of the exclusive features that make Leslie Controllers ideal for straight pressure control problems. He's listed in your classified directory under "valves" or "regulators". Send for bulletin described at left.

TRADE LESLIE MARK

REGULATORS AND CONTROLLERS

LESLIE CO., 299 GRANT AVENUE, LYNDHURST, NEW JERSEY

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For more information circle **58** on inquiry card.

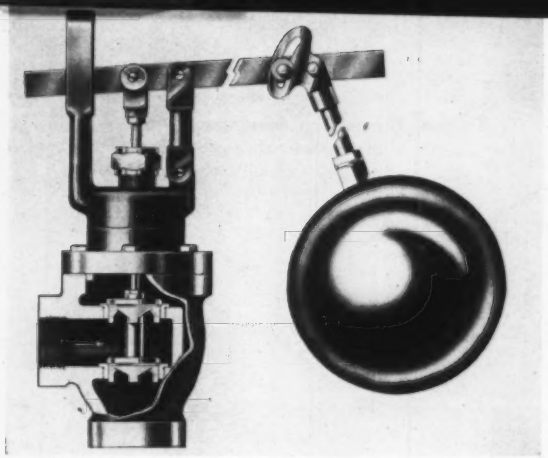


Fig. 5-1. Basic level regulator comprises float-operated single- or double-seated valve.

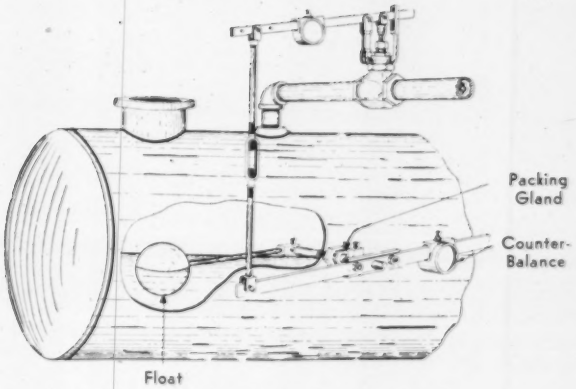


Fig. 5-2. Float actuator for closed tank.

Level Regulation

Regulators—No. 5

The simplest type of level regulator comprises a float-operated valve. For larger valves the float may operate a pilot which in turn controls the valve. Other regulators use displacement technique and thermal expansion of liquids or metals to actuate a valve. Level in water towers can be regulated by altitude valves functioning on the principle of a differential pilot.

C. S. BEARD
General Controls Co.

MOST TANK LEVEL problems are not difficult. As in all industrial automatic control situations, it is wise to first consider whether automatic control is to be applied, or whether manual operation is sufficient.

Consider, for example, a storage tank set on a hill to furnish water for a few oil-well pump engines, a drilling rig, and a few scattered houses. The tank has a capacity for about three-days' operation and is supplied by a large line from the water source. It also has a level indicator which is visible from many points of operating activity. As it is easy to drive up the hill in the morning, every three days, and open the valve, manual operation is the obvious choice unless other factors enter, such as danger to equipment, lack of personnel, etc. It is necessary to consider factors such as how often must the valve be closed? What will happen when a few rigs are added and more houses occupied? What will happen if the tank runs dry some night and the rigs shut down due to lack of boiler feedwater? Level control must be considered to avoid such occurances. A similar decision must be made in many other cases, such as the drain from the condensate hotwell of a steam power plant.

The most common level *regulator* (that is, one with no external source of power) uses the *float-controlled valve*. Hence discussion of level regulators resolves itself into a discussion of various applications of float-controlled valves to level control.

Ball Float Valves

Attaching a ball float to the arm of a lever-operated valve is the simplest approach to level control. Fig. 5-1 shows a float-operated valve, or *float valve*, for use in an open tank.

The float can be used inside a closed tank (Fig. 5-2) by bringing out the shaft connecting the float arm and the valve-operating arm through a packing gland. For closed tanks the float can be housed in a cage or kidney piped externally to the tank (Fig. 5-3). Housing the float in a kidney makes it necessary to bring the shaft through a stuffing box, as illustrated.

Stuffing boxes have the disadvantage of friction, due to packing and additional pivot points. Fig. 5-3, B shows a valve with a rotary stem which lessens the frictional effect of the stuffing box.

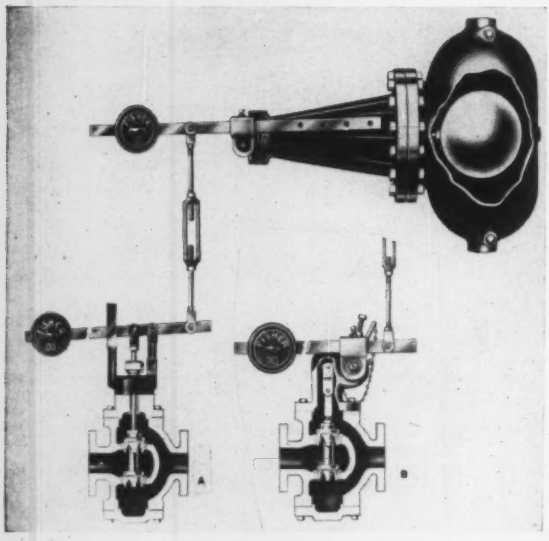


Fig. 5-3. Float cage can be piped to tank. Packing gland at left provides for linear shaft motion; that at right for rotary motion and reduced friction.

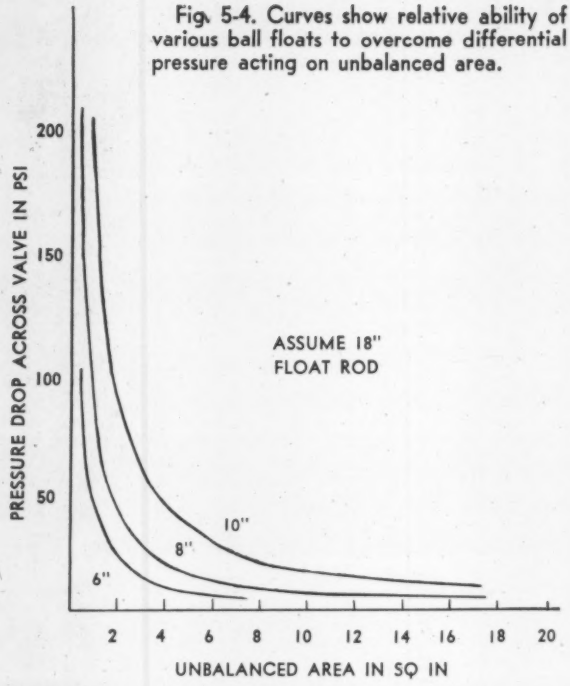


Fig. 5-4. Curves show relative ability of various ball floats to overcome differential pressure acting on unbalanced area.

Buoyancy and Force Factors

Floats exert power due to buoyancy. The buoyancy is equal to the weight of the liquid displaced by the float. Float requirements are calculated on the basis of a maximum submergence of one half of the sphere. The spherical float has the advantage of uniform buoyancy effect in any position. Other shapes are used to move vertical rods.

Taking into consideration the weight of water and the displacement of a hemisphere, the most common ball floats have the following buoyancies:

Table 5-1. Buoyancy and Weight of Copper Float vs. Diameter

Diameter (inches)	Buoyancy (lb)	Weight (lb)	
		Thick wall	Thin wall
6	2.04	1.08	0.75
8	4.84	2.40	1.33
10	9.46	4.50	2.07
12	16.28	6.50	2.97

Note that floats of 10″ size produce 60 to 70% more operating power than 8″ floats, and, therefore, find application for larger regulators and lighter fluids.

Effective buoyancy is the tabulated value caused by water displacement multiplied by the effective length of the arm which operates the valve. In Fig. 5-1 the length of the float arm is measured from the fulcrum to an imaginary point on the surface of the liquid where the force line of the buoyancy would penetrate if the floating action could be concentrated in one point. The forces causing the regulator to open or close operate also on a lever arm whose length is the distance from the stem to the fulcrum. The effective length in this case is the difference of the two lever arms.

Counteracting the buoyancy is the *weight* of the ball float. This weight varies with float size, thickness and type of material. Table 5-1 indicates weights of *copper floats* within limits of recommended wall thicknesses.

Weights of stainless-steel floats can be obtained by multiplying the weights given in Table 5-1 by 0.963; in the case of Monel by using a factor of 1.027. The weight of the float can be counterbalanced as shown in Figs. 5-2 and 5-3.

Friction in the valve movement contributes an undeterminable force which depends on so many varying factors that it cannot be calculated. Friction is reduced by using a rotary stem rather than a sliding stem (Fig. 5-3).

Both single- and double-seated globe bodies are suitable for float-actuated valves. Regulators designed for use on make-up flow will open on the lowest allowable level and close as the level reaches a maximum. When installed on the outlet from a tank the regulator must open as the level rises, and close when the level drops. *Pressure differential* across the regulator creates additional forces which must be overcome by the buoyancy of the float.

The effect of float buoyancy is increased by the length of the float rod, but the longer the effective rod length the greater will be the level change required to operate the valve through full travel. Design considerations for a ball float valve thus include (1) size of float, (2) length of float arm, (3) direction of flow, and (4) unbalance caused by differential pressure acting on the valve seat area.

Fig. 5-4 shows the relationship between the pressure differential and the unbalanced area of the valve seat

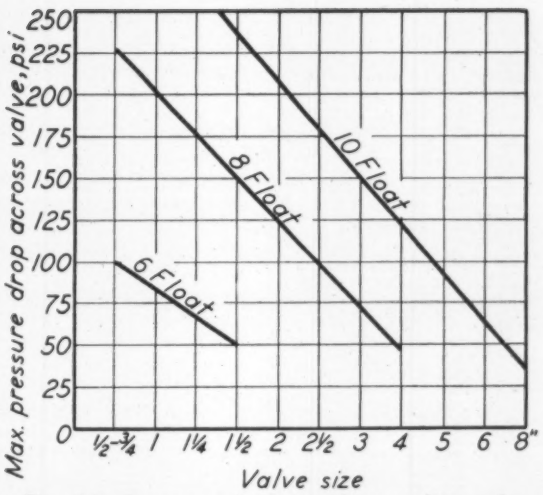


Fig. 5-5. Recommended operating conditions for a float-cage-lever valve with rotating-stem packing gland. Note that higher pressure-drop across valve can be tolerated than with sliding-stem gland (Fig. 5-6).

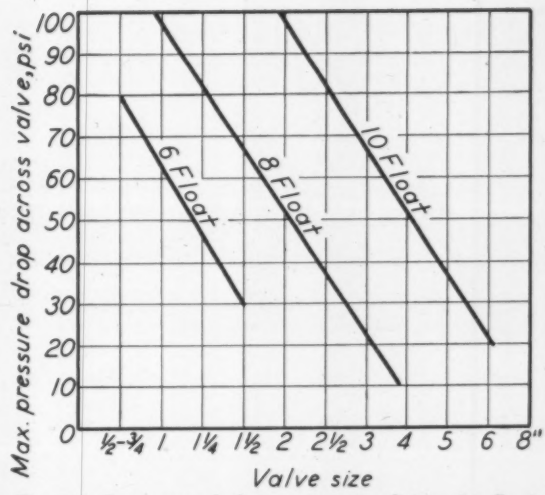


Fig. 5-6. Recommended operating conditions for float-cage-lever valve with sliding-stem gland. Note that added friction of stem reduces the maximum pressure drop across valve that can be handled by float.

(or seats), assuming an 18″ float arm, on floats of 6″, 8″, and 10″ diameter. This family of curves is just an indication of effect because it assumes that the buoyancy effect just equals the differential-pressure effect acting on an area (the seat ring area in a single-seated valve, or the difference in areas in a double-seated valve). For example, if the valve has an unbalanced area of 4 sq in, and if the maximum pressure drop is 20 psi, then an 8″ float will have a buoyancy just equal to the pressure-differential effect. A 6″ float would be too small; a 10″ float should be used.

Recommended operating conditions based on the use of a float-cage-lever valve using a *rotating stem* (Fig. 5-3) are shown in Fig. 5-5. A float of the same size will not overcome as large a pressure drop in the case of a sliding-stem valve (Fig. 5-6). Both of these diagrams assume that the weight of the float and the weight of the inner valve have been counterbalanced.

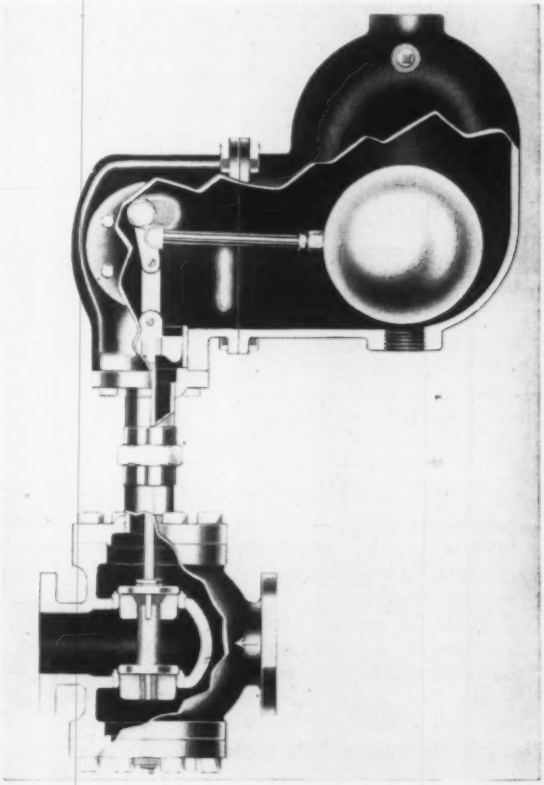
Fig. 5-7 shows a variation of the float-cage type that eliminates the packing required to bring the float arm movement out of the float cage, or the stem movement out of the valve body. This equipment can be used only when the cage is filled with the same liquid flowing through the regulator. This system is used, for instance, to drain large compressor aftercoolers and similar equipment in which the required drain capacity exceeds the capacity of a tray. A reverse toggle leverage may be used to close the valve when the float rises. In this application the purpose is to hold a level in a tank by controlling the influent.

Regulators discussed so far are of the double-seated type, which are partly balanced. When flow rate and pressure are low, it is possible to use single-seated regulators. Double-seated regulators do not provide tight shut-off. Where shut-off is a requirement, single-seated valves become necessary.

Internal-pilot Level Regulator

When larger-size valves are required, the unbalanced forces may increase to an extent where a regulator cannot be used. (Regulators were previously defined as instruments which can be actuated *without* the use of an external power source.) When large valves and large forces are involved, it may be neces-

Fig. 5-7. Float cage and valve connected to eliminate packing.



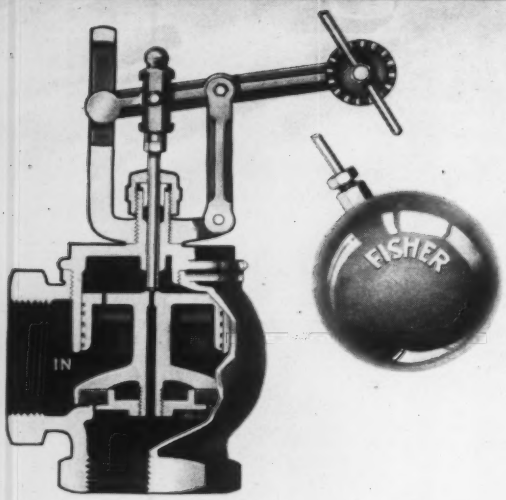


Fig. 5-8. Line-pressure holds valve closed until pilot opens and reduces this pressure.

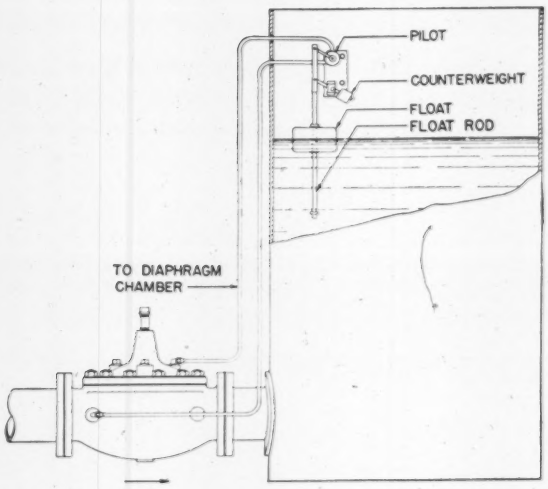


Fig. 5-10. Pilot can be located remotely.

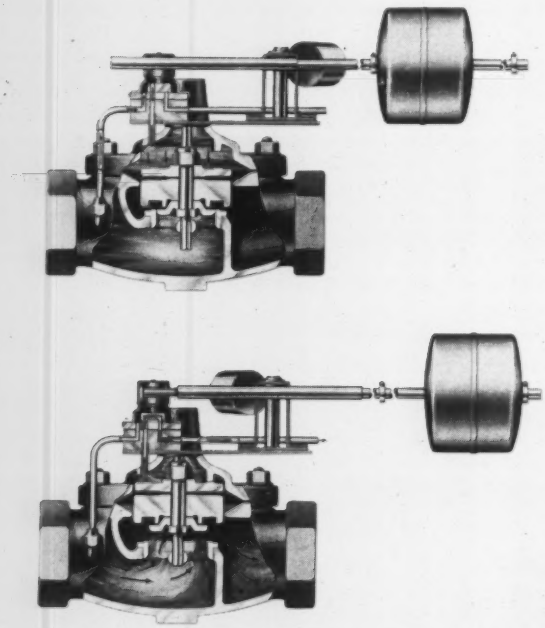


Fig. 5-9. Float operates integral pilot so that line pressure either acts on top of diaphragm to close valve (top) or else top of diaphragm is vented so that line pressure opens valve (bottom).

sary to use pilot-actuated level regulators. Where the pilot is an integral part of the valve and uses line pressure the classification as regulator does not violate the definition.

Fig. 5-8 illustrates a type of internal-pilot-actuated regulator. It is essentially a single-seated valve with a balancing piston. The valve stem is not rigidly attached to the inner valve, but its end forms a needle valve controlling the flow through a vent hole in the valve plug. A hole of smaller size located in the piston introduces pressure on the top. The force developed by the difference between the larger piston area and the smaller port area acts in an upward direction. The stem position forms the stop. When the stem moves downward, the needle valve is closed, pressure equalizes across the piston, and the inner valve closes the seat. For tight shut-off a resilient seat can be used, where temperatures do not exceed 150°F. Disadvantage of this construction is its limitation to clean fluids because any foreign matter causes the piston to stick, or the needle valve to clog. Pressure-drop limits are from a minimum of 10 psi (required for actuation) to an allowable maximum of 200 psi.

Another type of integrally mounted pilot (Fig. 5-9) allows high pressure to be exerted upon a diaphragm to throttle the regulator. With this system adjustments may be made by setting the stops on the horizontal rod a given distance apart. The pilot is counterbalanced so that the float will move it to one position upon rising level and the opposite position upon contact with the lower stop.

Externally-mounted Pilot

The pilot can also be mounted in the tank (Fig. 5-10) to control the line pressure acting on the diaphragm of a remote regulator. This system gives good results when used with a small ball float valve (Fig. 5-11) which varies the effect of line pressure on a spring-loaded valve to throttle the influent. The line valve is wide open when the float is at its lowest position because the pilot float valve is wide open and reduces the liquid pressure on the diaphragm. As the float rises, pressure on the diaphragm of the spring-loaded valve increases and closes the valve.

The float that actuates the pilot (which in turn controls the valve) also can be housed in a float chamber or kidney.

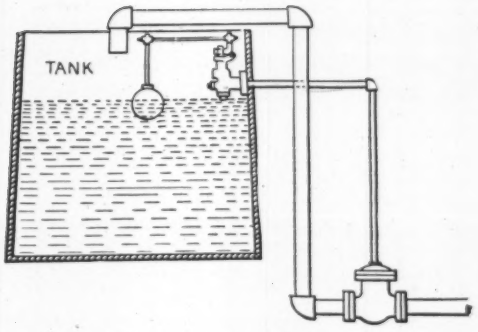


Fig. 5-11. Ball float pilot throttles level regulator.

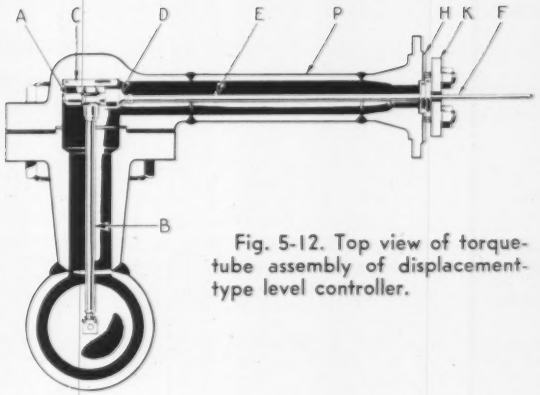


Fig. 5-12. Top view of torque-tube assembly of displacement-type level controller.

Displacement-Type Controllers

The problem of friction and lost motion, inherent in the ball-float or buoyancy-type instrument is eliminated in displacement-type instruments in which a cylindrical float or *displacer* is weighted so that it sinks in the fluid to be measured (Fig. 5-12). Buoyant forces from the cylinder exert a torque at the end of rod B, which twists socket D. The torque tube consists of solid rod F in hollow shaft E, both of which are welded to socket D. As socket D is twisted, hollow rod E twists, but rotary shaft F rotates and is connected externally to pilot. No stuffing box is required. The torque tube operates a pilot, usually connected to an air supply, hence this instrument is a controller rather than a regulator.

Thermal Level Regulators

Advantage can be taken of the difference in temperature between a liquid and its vapor, or water and its vapor (steam). This principle is used, for example, for a disc evaporator in a pulp mill, which offers various difficulties to the use of a float, a displacement type, or a bubbler-type level indicator. For many years the accepted method for level indication in this special case has been to insert a thermal bulb through the tank at the point of the normal liquid level and to observe temperature changes as the bulb is enveloped first by vapor and than by liquid. This change could also operate a temperature regulator.

Thermal Level Regulators

Fig. 5-13 shows a different type of thermal level regulator using a water-filled bellows system. The inclined "generator" comprises two concentric tubes. The outer tube is a sealed system (with water) that actuates the bellows on the regulator valve. The inner tube is connected to points above and below the drum water level so that the level in the inner tube corresponds with the level in the drum. Hence, when the level falls, more hot steam enters the inner tube, heating the water-filled closed system and expanding the bellows. This opens the regulator valve and allows feedwater to enter the drum. When the water level rises, less steam is in the generator, the temperature of the closed-system then falls, and the bellows closes the valve. The regulator shown in Fig. 5-13 has a proportional band of about six inches.

The same principle of temperature change caused by change in water/steam interface can be used also to vary *expansion* of the inclined tube itself (Fig. 5-

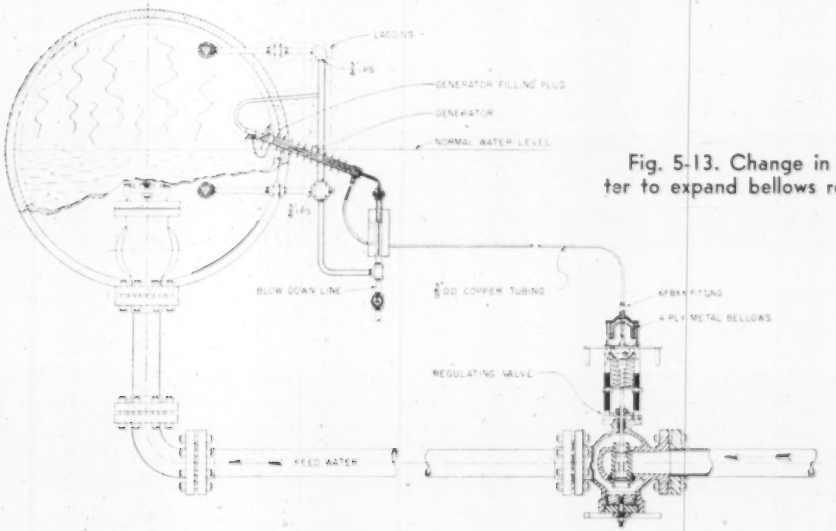


Fig. 5-13. Change in steam/water interface heats water to expand bellows regulator.

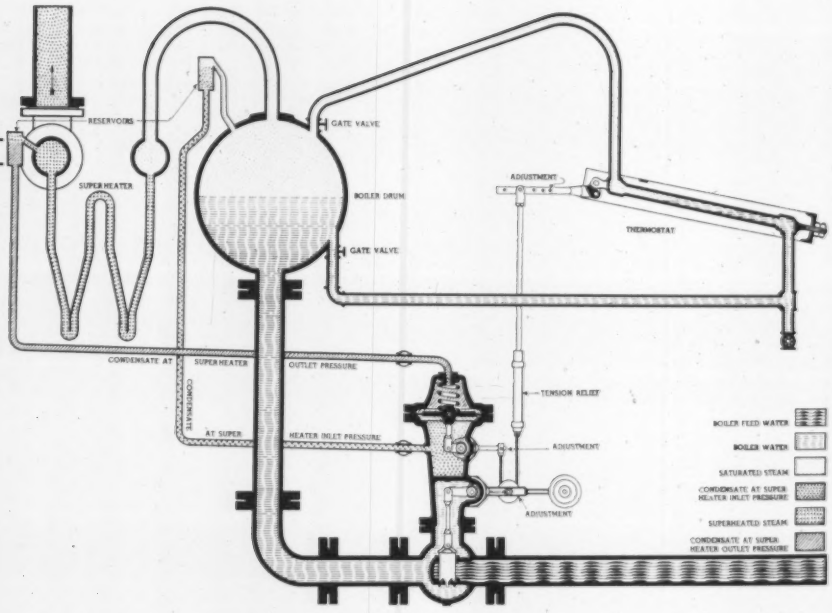


Fig. 5-14. Expansion of inclined tube actuates regulator.

14). As the water level falls and steam enters, the "thermostat" expands. This motion can actuate an indicator, a pilot valve, or the feed-water valve itself. The valve in Fig. 5-14 combines level control with pressure-differential control.

Altitude Valves

Altitude valves are so named because they are used to regulate the level in elevated tanks, even though valve and control are installed on the ground. The principles of a differential pilot (spring loaded, or differential valve) are applied to this type of level regulator to accomplish several variations in operation:

Single-acting altitude valves which handle two-way flow (where the reverse flow passes through the same line), as well as double-acting regulators (where a separate line is used for the discharge from the tank) are made (1) as "standard" valves, and placed in the upstream pressure line to maintain a uniform water level in tank, standpipe or reservoir. (2) "Differential altitude valves" permit a delay in the opening of the valve against upstream pressure after a closure under full tank head until the tank level lowers to any predetermined depth and/or line pressure drops to desired pressure. Fig. 5-15 shows piping arrangements for this type of valve. (3) A "stop check" piston incorporated in a valve ads the feature of a reverse-flow check valve. (4) Where automatic isolation of the storage tank from the influent line is required (e. g., to build up an abnormal upstream pressure in case of fire) a combination diaphragm pilot is used. Here a second diaphragm is housed in a separate chamber, and acts on the stem of the main pilot by means of levers. (5) In special cases, notably where it is required to maintain a very low tank head and where the influent pressure is rather high, semi-throttling valve control can be provided which permits gradual closing of the valve to shut off the influent line when the level approaches the desired maximum.

Other Methods of Level Control

It is recognized that numerous other methods of measuring level are used in addition to the ones described. Some of these are: (1) completing an electric circuit between probes at desired levels, (2) interruption of beam from photoelectric cell by liquid surface, (3) reflection of high-frequency waves from surface of liquid, (4) movement of displacement type float, as has beeen mentioned, etc.

These and other methods are used to energize solenoid pilots or to operate pneumatic pilots. The pilots in turn may position a control valve. These approaches are important, but do not fall into the scope of regulators and have to be classified under instrument-type controls.

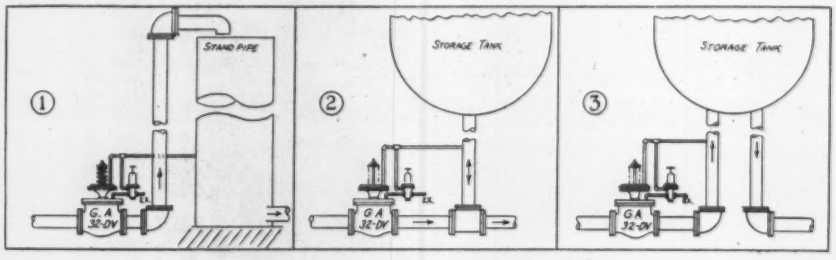


Fig. 5-15. Altitude valves come in several variations. Shown here are different piping arrangements for the "differential" type.

The Electronic Business

These excerpts from a survey recently conducted by *Fortune* magazine decribe today's electronic industry, and venture some startling predictions.

WILLIAM B. HARRIS

ONE of the authentically great events in the life and growth of an economy is the emergence of a big new basic industry. In the past half-century only automobiles, air transportation, electrical apparatus, oil, and chemicals have met this grand test. Today another industry can be added to the list—*electronics*.

Ranked by *value added in manufacture*, the electronic industry came from the obscurity of forty-ninth place in 1939 to fifth place in 1956, directly behind the chemical business and ahead of the electrical industrial-apparatus industry (the first four—automotive, steel, aircraft, and chemicals).

In the past decade, the electronic industry has grown from less than $2.5 billion in annual sales to $11.5 billion; it has doubled since 1950. Electronic sales in 1939 were less than $1 billion; the "industry" consisted of radio and a few military experiments.

More than half of today's enormous business—$6.2 billion— is derived from manufacturing. These products are made by about 500 manufacturers, supported by 3,000 to 4,000 suppliers of components or parts.

THE BIG ELECTRONIC MARKETS

	(In millions) 1947	1950	1956
Military			
Aircraft equipment	$ 45	$ 150	$1,015
Missiles	00	10	640
Other	30	240	1,335
Total military	$ 75	$ 400	$2,990
Consumer			
Radio	$ 672	$ 343	$ 304
Television	51	1,110	908
Other	80	136	210
Total consumer	$ 803	$1,589	$1,422
Industrial			
Communications	$ 52	Not available	$ 250
Computers	4	Not available	250
Controls	12	Not available	180
Other	80	Not available	320
Total industrial	$ 148	$ 375	$1,000
Replacement parts	$ 100	$ 245	$ 810
Total	$1,126	$2,609	$6,222

The remainder of the industry's gross—$5.3 billion—is accounted for by electronic product distribution and servicing and commercial broadcasting. This area teams with entrepreneurs from the size of a nationwide broadcaster like CBS to the corner radio-TV repairman.

All told, the electronic industry today employs about 1,500,000 people; it probably had fewer than 150,000 employees in 1939. Almost 100,000 of the nation's 500,000 engineers are in electronics.

By 1960, the electronic industry may sell $16 billion worth of goods and services; $22 billion dollars worth or more by 1965 is a possibility. These are the dollar measurements of a magnificent potential. Along with the magnificent potential, however, the electronic industry has rapidly multiplying problems.

Military Market

Overshadowing all its other problems is the fact that almost half the industry's product is bought by the military (Table). This makes electronics in good part a child of government—a heavily subsidized industry. A dividend from military orders, of course, is the new technical knowledge that can be put to work in other markets. The digital computer, for example, now the darling of the office-machinery business, resulted from the spending of unrevealed millions by the military for superspeed data-processing devices developed for advanced scientific work and for automatic fire and flight control.

Concentration

The concentration of electronic business in the hands of a relatively small number of producers is following the classical pattern that has marked all large U. S. industries. In electronics, as elsewhere in U. S. industry, genuine competition inevitably eliminates some of the competitors. The making of receiving tubes, the industry's largest component in terms of dollar volume ($375 million last year), is now in the hands of only eleven companies, the survivors of dozens once in the field.

The survey shows that a high proportion of all kinds of electronic manufacturing is already in the hands of the twenty-two companies that gross over $100 million a year. They produce 70% of all electronic

Only the automobile, steel, aircraft and

business. These outfits are diversified across the board—diversified both in electronic and in non-electronic manufacture. In 1955 they billed $12.7 billion worth of business, $3.9 billion of it electronic. Their total electronic business was 27% of their total sales in 1950, and in 1955 they increased this to a little over 30%. Their earnings on sales and net worth were better than the results shown by nineteen medium-sized ($25 million to $100 million) companies in electronics, or by fifty-three small companies (under $25 million). Electronic sales of the medium-sized companies actually dropped $34 million from 1953 to 1955. A further concentration of electronic business in the twenty-two big companies is the only prediction that makes much sense.

Vacuum Tubes Vs Transistors

In dollar volume the older "dynamics," the vacuum tubes, still outsell the newer semiconductors by a wide margin. Indeed, the tube business last year grossed $885 million—a full third of the $2.3 billion spent for all components. Compared with this tremendous volume, the $77 million worth of semiconductors sold last year may seem like peanuts.

But sales of semiconductors are rising on rocket-like trajectories. The electronic business as a whole has doubled in size in the past five years, but sales of semiconductors are doubling and even tripling annually. Transistor sales, for example, rose from nothing in 1952 to $37 million last year. They will double again this year and, by 1965, are expected to reach $300 million. The combined sales of diodes and rectifiers rose from $19 million in 1955 to $40 million last year. Sales of silicon rectifiers totaled about $3 million in 1956. They will triple this year, and should amount to well over $100 million by 1965. Since 1947, semiconductor diodes have pushed most vacuum-tube diodes out of the market.

Taken together, sales of all semiconductors are expected to reach a level of at least $500 million by 1965, a sevenfold gain over the present level.

Companies in semiconductor manufacturing guard their sales figures carefully, but the following rankings are believed correct for 1956:

Texas Instruments placed first by a comfortable margin. Transitron Electronic Corp. of Wakefield, Massachusetts, founded in 1952, ran neck-and-neck with General Electric for second place. Sylvania, the second-ranking tube maker, was fourth. Hughes Aircraft, which entered electronics as a military-equipment manufacturer, was fifth.

Other Components

Taken together, the dynamic and static components account for an impressive $2.3 billion of sales annually, a volume equivalent to more than one-third of the total sales of electronic end products. (In computing the size of the total electronic equipment market, only the $800 million of components sold as replacement parts was included in the $6.2-billion total; the $1.5 billion worth of components that went into new equipment was not included, in order to avoid duplication.) The static components, because they are so numerous, account for the great bulk of component sales (there are four capacitors and five resistors in an electronic circuit for every dynamic component); last year $1.4 billion worth of static components were sold. Capacitors accounted for about $220 million of this total, resistors $175 million, transformers and coils $125 million. A miscellany of filters, tuners, speakers, etc., added $325 million and the $550-million remainder was made up basically of "hardware"—sockets, wire, terminal boards, etc.

Industrial Market Rises

Today, electronics is just beginning to be felt in the many industrial-commercial markets, but volume is at a respectable $1-billion annual rate, up from $750 million in 1955 and from $150 million in 1947.

The brightest performances in these markets are now being given in the communications and business-machinery fields. In communications, sales last year were about $250 million, most of it in broadcasting equipment and mobile radio. This does not include the expenditures by Bell Telephone, which is presently committing about a fourth of its capital budget—$500 million in 1956—for electronic facilities.

The market for industrial television, quite small today, could boom. And certainly the potential market for industrial control devices is far larger than the $180 million it accounted for last year. Minneapolis-Honeywell is the big company in this field today, but many smaller firms (e.g., Consolidated Electrodynamics of Pasadena and Beckman Instruments of Fullerton, California) specialize in control devices and seem to do well on smaller volumes.

Most electronic industrial-control devices are rather simple today, in part because most businessmen are skeptical about the reliability of complicated electronic mechanisms. But enough new, clever, industrial instrumentation is being sold (on-line mass spectrometers for continuous-flow processes, for example) to indicate that companies in the field can soon broaden their markets greatly. And no one knows how much unmined gold lies in the welter of industrial markets individually so small that they are today lumped under the heading of miscellaneous (where the computer market was found in 1952). These "other" industrial markets for electronics last year amounted to about $320 million. Scientific instru-

mentation was the most important element in this sales volume.

Computers

The real fascination of the $11.5-billion electronic industry, growing at the rate of more than $1 million a day, is not its size but the way it produces completely new products that suddenly explode into major businesses. Such an explosion is now occurring in computers.

The first large-scale electronic computer to process business-office data was delivered just 3½ years ago —in January, 1954. It was a Univac I, made by Remington Rand, now a division of Sperry Rand. General Electric's huge Major Appliance Division, in Louisville, Kentucky, was the customer. Today more than 200 computers in the $1-million-plus class (considered large computers), more than 800 machines that cost $100,000 to $500,000 (medium), and about 250 selling for less than $100,000 (small) are in business use.

Computer sales are close to $350 million this year and will probably hit a $1-billion rate by 1960; $2 billion by 1965.

Finding a large company that doesn't have at least one computer at work is becoming more and more difficult. Conservative U. S. Steel already has three installations. G. E., however, is the largest user; it has eight $1-million computers, twenty-three in the $250,000 class, thirty-one additional computers on order.

Despite all the problems they bring, electronic data-processing machines provide the only hope for handling the mass of paper work that is being produced by the U. S. economy. Since 1920, manufacturing productivity has increased more than 100% while the number of factory workers has risen only about 55%. By contrast, it took one clerk to process the data on $47,000 worth of business in 1950 and, without electronic data processing, it still takes one clerk to process the paper work for $47,000 worth of business.

The computer industry also is in the process of consolidation. Most of the small companies in the field have either been absorbed by large companies or have folded.

From its beginning in 1948, the industry has been beset with major business problems that its best computers have been unable to solve. Here are the major ones:

Selling: A painful problem in communications exists between the computer maker and his customer.

Manufacturing: Production is as backed up as a super-highway on Sunday.

Financing: Because more than 80% of the industry's sales are on a rental basis, annual financing requirements are enormous.

Obsolescence: Five years is the technical life of most machines today.

Profits: There are none, not even for IBM, today's leading company in the field.

However, it appears that the major competitors have the resources to survive. But survival without mergers among the remaining smaller manufacturers, some of whom have excellent general-purpose computers, is another matter. They struggle against huge financial odds and, at some point, will have to obtain large amounts of capital.

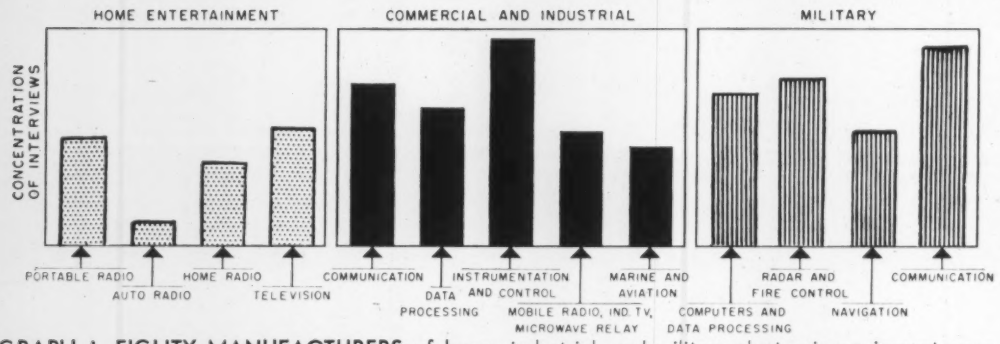
Special-Purpose Computers

Meanwhile, a large and completely different computer market is just being tapped. It is the market for special-purpose business computers, tailor made to do specific data-handling jobs less expensively than they can be done with general-purpose machines. Banks, for example, require computers with large file capacity, and capable of fast check handling and fast production of monthly statements. The Bank of America had Stanford Research design ERMA (Electronic Recording Machine—Accounting), a prototype machine to handle the accounting for its many branch banks. General Electric has a contract to develop about thirty-six commercial machines for 400 of Bank of America's 600 branches. Because special-purpose machines will largely be tailor made, outright sale will take the place of rental. Teleregister Corp. of Stamford, Connecticut, a subsidiary of Ogden Corp., has installed five special-purpose computers for airline-reservation work, and two special-purpose machines for inventory control. Bendix Aviation inclines toward the special-purpose market.

The Next Big Market

All computer manufacturers also have one eye on another computer market that has not yet been tapped —factory automation. The computer in this instance will direct production, thus becoming the heart of the so-called automatic factory. Although the completely automatic factory is still a wild-blue-yonder concept, a high degree of factory automation, based on the computer, is certainly possible and many electronic companies are interested in the market.

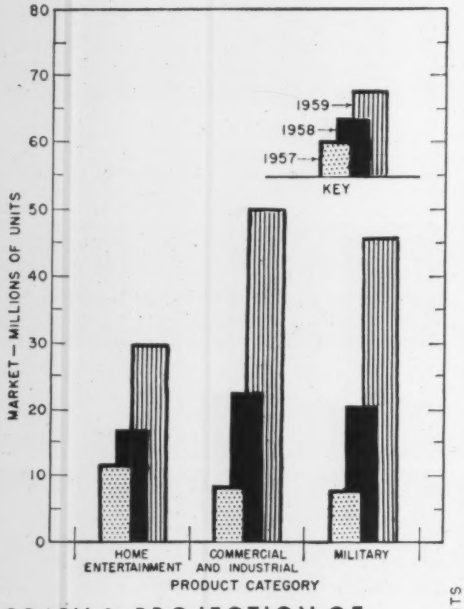
Predicting when these big new factory markets for electronic gear will open up, and deciding what kind of product to take to market won't be any easier than other decisions that have confronted the electronic industry. The best bet, based on experience, is that industrial demand will not develop in any orderly way—it will explode.



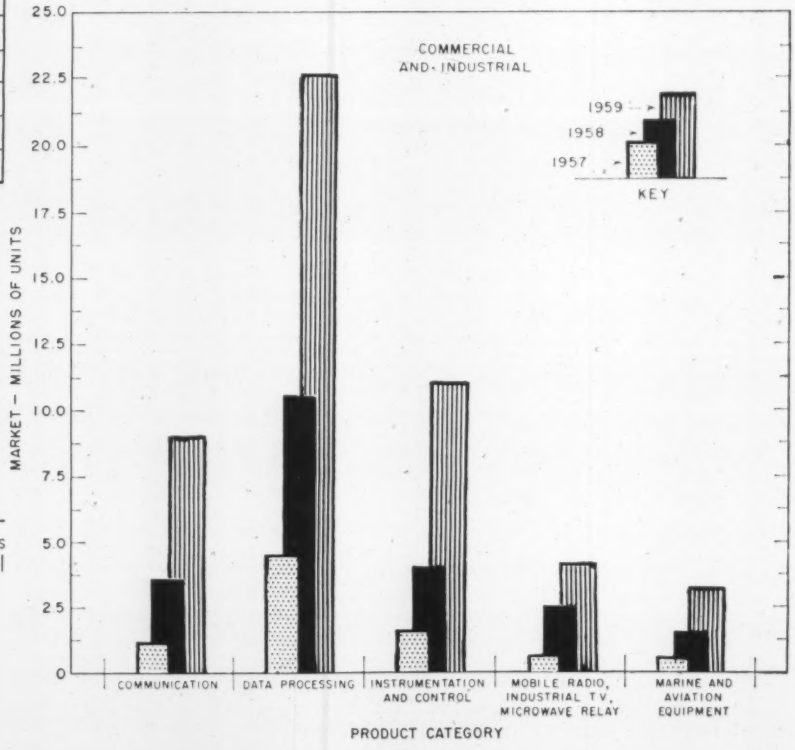
GRAPH 1. EIGHTY MANUFACTURERS of home, industrial, and military electronic equipment were interviewed for this report.

SRI study for Philco reveals that Most Important U.S. transistor markets will be:

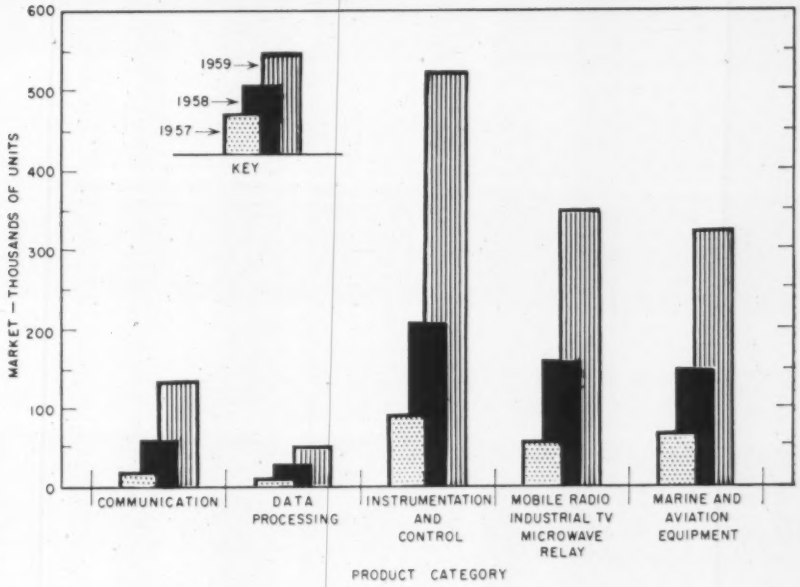
1. **Industrial**
2. **Military**
3. **Home entertainment**



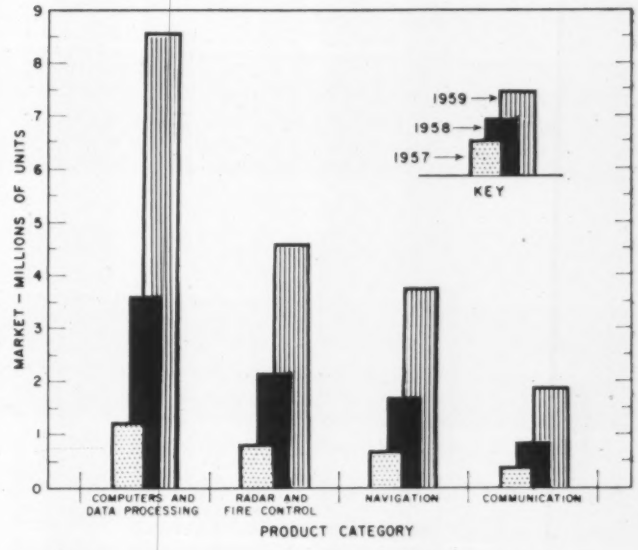
GRAPH 2. PROJECTION OF GROWTH for germanium and silicon transistors in the three major categories.



GRAPH 3. PROJECTED MARKET for germanium transistors in commercial and industrial category.



GRAPH 4. PROJECTED MARKET for silicon transistors in commercial and industrial category.

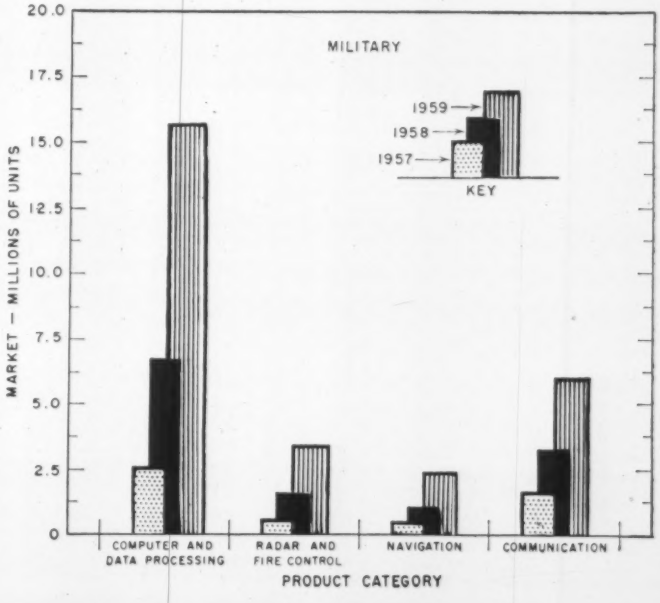


GRAPH 5. PROJECTED MARKET for silicon transistors in military category.

Stanford Research Institute has recently completed a comprehensive study of the transistor market for the years 1957, 1958 and 1959. The study, commissioned by the Lansdale Tube Company Division of Philco Corporation, is based on interviews with 80 manufacturers and developers of electronic equipment, of the type shown in graph 1.

Graphs 2, 3, 4, 5 and 6 portray pictorially and dramatically that:

1. The transistor market is in a period of great change and growth.
2. By 1958 both industrial and military demands are expected to exceed home entertainment needs.
3. In 1959 industrial and military demands will far exceed home entertainment needs.
4. Total production of germanium and silicon types will increase almost five times in the next three years.
5. The industrial and commercial market will become the largest single market.
6. The primary two users in the industrial and commercial market will be data processing and instrumentation.



GRAPH 6. PROJECTED MARKET for germanium transistors in military category.

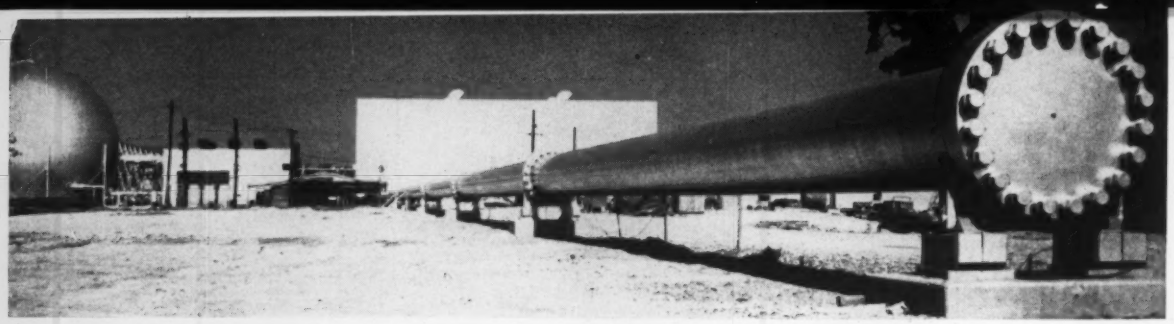


FIG. 1. PRESSURIZED AIR, drawn from this 720' storage bottle (right) rushes through test chamber and into the huge vacuum sphere in the left background.

Blow-Down Tunnel Results

On-line computers deliver reduced, meaningful data only 20 seconds after a run in this Mach 5.5 blow-down tunnel.

AERODYNAMIC AND ENGINE data for some of the country's most important defense programs, the ICBM, B-58, F-105, etc., are the concern of the Air Force's Arnold Engineering Development Center (AEDC) at Tullahoma, Tennessee.

The three major units of the AEDC—engine test, gas dynamics, and the propulsion wind tunnel—encompass a wide range of capabilities in speed and altitude. The gas dynamics facility is designed to probe the problems of extreme pressures, temperatures and flow characteristics associated with flight at five and ten times the speed of sound (3,800 to 11,000 mph). Its most important feature is the ability to simulate and, in some cases, duplicate the conditions encountered by a full-scale missile, aircraft or projectile in actual flight.

"Blow-Down" Tunnel

The facility comprises two separate plants: The continuous-flow plant and the intermittent-flow plant. The intermittent-flow plant contains two "blow-down" wind tunnels, one is tunnel E-1, the first major wind tunnel AEDC placed in full operation (Fig. 1). E-1 has a range of Mach 1.2 to 5.5 (900 to 4180 mph at sea level conditions). Over most of this range, the Mach number does not vary by more than 0.01 over the test area.

In blow-down operation, air stored under high pressure is released to rush through the test section and blast a model for short durations (Fig. 2). Air supply for tunnel E-1 is a 720′-long, high-pressure tank which can store 50 tons of air at pressures up to 4,000 psig. Controlled by a valve, this air rushes through a 12″-square test section and into a 72′-dia evacuated steel sphere.

The tunnel operates intermittently for 15 minutes or less, then air is pumped back into the reservoir and evacuated from the vacuum sphere. An average run lasts about one minute.

The flexibility of model mounting (Fig. 3) and the ability to rapidly change Mach number and density level make the tunnel extremely useful for development testing.

Data Reduction

Initially, pressure measurements were made by fluid manometers and other transducers with data recorded photographically or manually. With these instruments, static pressures are measured to a digital accuracy of 0.1%.

Now the enormous volume of data accumulated in the development tests is fed to an automatic "on-line" data reduction system that measures, scans, computes, and presents the results of a wind tunnel test in one continuous operation for each test point as the test progresses.

Raw pressure data leave the tunnel via one-hundred-and-fifty pressure balances (Fig. 4). These transducers provide accurate static pressure measurements on as many as thirty channels operating simultaneously.

Electromanometer

Each pressure balance is monitored by a servo amplifier (Fig. 5). In combination, the pressure balance and servo amplifier are known as the Electromanometer, a precision pressure-indicating system.

The Electromanometer is an electronic null-balance servo-type system. Because of its rapid response time (five seconds full scale), it is particularly adaptable

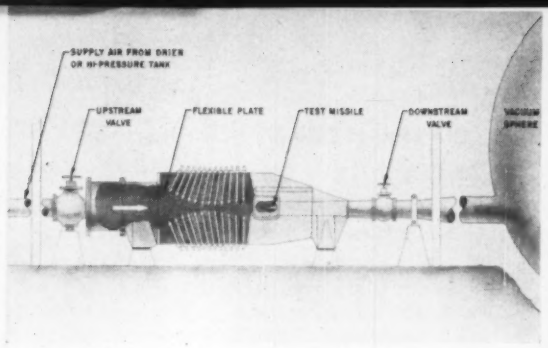


FIG. 2. **OPERATION** of test section E-1.

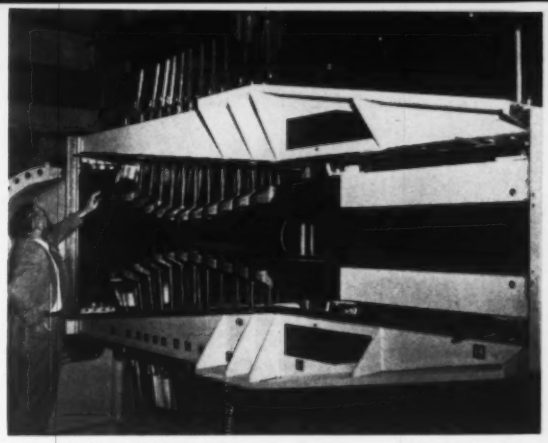


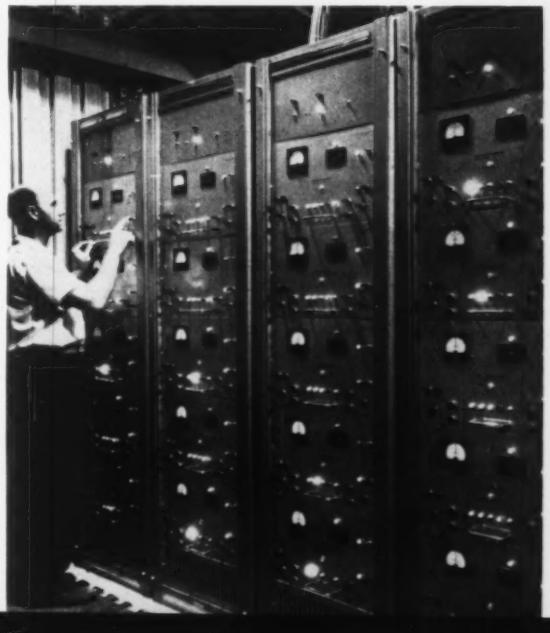
FIG. 3. **FLEXIBLE STEEL** nozzle and model insertion opening of tunnel E-1; one sidewall is removed.

in 90 Seconds

A staff report

FIG. 4. **THESE CEC PRESSURE** balances are used in recording pressure data.

FIG. 5. **TUNNEL E-1 USES** this bank of servo amplifiers in recording pressure data.



to applications where a large number of measurements must be made.

Two-Way System

When a test is underway, each servo amplifier can act as a five-channel, semi-automatic pressure measuring system, feeding information to—and receiving commands from—the computer. With this two-way intelligence operation, the computer gets information stating which of the five channels is being read, what the digital value is, whether balance has been achieved or not, and whether an overload is present.

Looking at all this information, the computer then either prints out the computed pressure values, waits until balance occurs, or, in the case of an overload, prints an error sign for that channel. Then the servo amplifier is released, and switched automatically to the next channel.

The entire system is capable of reading up to 150 pressure points with 0.1% full-scale accuracy and providing data twenty seconds after the run. The system was designed by Consolidated Electrodynamics Corp.

E-1 Emulates Free-Flight

Data from tunnel E-1 is directly comparable to free-flight, full-scale testing, such as the much more expensive method of rocket firing.

The first test performed in E-1 was on the Hughes Aircraft Company's "Falcon," an air-to-air guided aircraft rocket. Following this initial work, the tunnel performed inlet ducting tests for Republic Aviation Corporation's F-103 and F-105 fighters.

On-line testing was started in tunnel E-1 in September 1955. Since that time tests have been made for North American Aviation, Republic Aircraft, AVCO, General Electric, and many others.

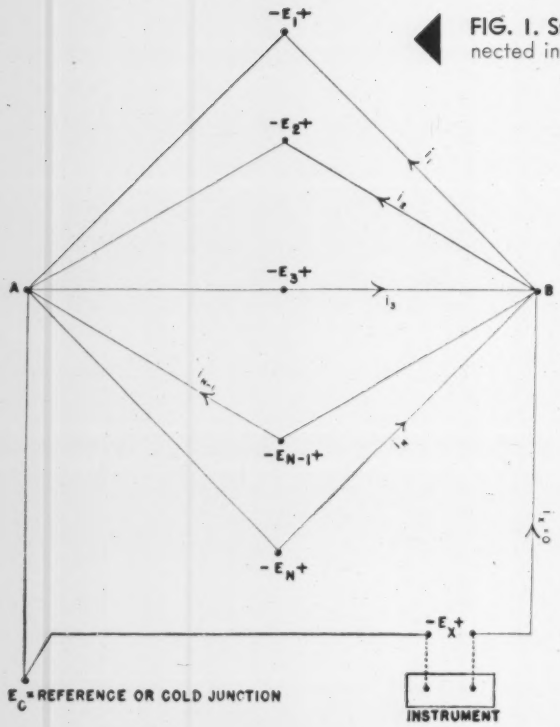


FIG. 1. SCHEMATIC DIAGRAM of thermocouples connected in parallel.

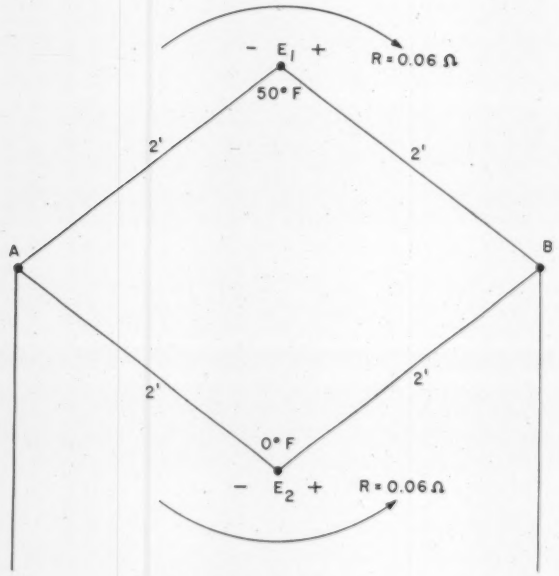


FIG. 2. TWO THERMOCOUPLES in parallel used to evaluate Peltier effect.

Accuracy of THERMOCOUPLES

DIRECT-READING, industrial-type temperature controllers and recorders commonly use a single thermocouple, which controls or records a localized temperature condition. If a temperature gradient is present, several thermocouples located at strategic positions and connected in parallel provide a more reliable estimate of the *average temperature*. The average emf developed by the parallel-connected couples is then applied to the potentiometer circuit of a suitable temperature recorder or controller. This method can control or record the average temperature—provided the user is aware of the limitations.

Sources of Error

When thermocouples are connected in parallel and the junctions are at different temperatures, currents will circulate within the network and will introduce errors in the indicated average temperature. Errors can be introduced as a result of (1) the Peltier effect, (2) the Thomson effect, (3) the power loss in the network, and (4) variations among the individual thermocouples comprising the network.

The type of system under discussion is shown in Fig. 1, a schematic diagram of thermocouples connected in parallel. As indicated, there can be any number of parallel-connected couples between points A and B. The arrows indicate a possible circulating current flow. The driving potential differences are of the order of a millivolt, so the magnitude and effects of these circulating currents can be kept reasonably small if certain restrictions are placed on the resistance value of the thermocouple loops.

Peltier Effect

The Peltier effect relates to the release or absorption of heat at a junction when current flows through the junction.

We will consider only two thermocouples in parallel (Fig. 2) with each couple leg comprising 2′ of No. 10 gage copper and 2′ of No. 10 constantan wire; each couple loop (A-B) has a resistance of 0.06 ohm. The junctions of the two couples are at 0° and 50° F. According to Roeser[3], the wattage generated or absorbed at a junction is:

$$W = P\,i \qquad (1)$$

where W is the watts generated or absorbed at the junction, i is the current in amperes passing through

Parallel-connected thermocouples can measure average temperature to ± 0.1% if certain precautions are followed.

PAUL W. KILPATRICK
U. S. Dept. of Agriculture

FIG. 3. CONTROL INSTRUMENTATION for the temperature-time cycling of refrigerated compartment.

IN PARALLEL

the junction and P is the Peltier coefficient or Peltier emf, in volts.

The Peltier emf is defined as:

$$P = T\,dE/dT \qquad (2)$$

where T is the absolute temperature (°R) and dE/dT is the rate of change of junction voltage to temperature, in volts per F° (0.022 mv per F° for the above example).

The Peltier emf's for the junctions in the selected example, calculated from equation (2), are 0.0112 volt at the 50°F junction and 0.0101 volt at the 0°F junction. The difference, 0.0011 volt, is the driving force for the circulating current in the network of the example. The total resistance of the loop is 0.12 ohm. Thus circulating current, i, is 0.0011/0.12, or 0.0092 ampere.

From equation (1), the heat *absorbed* at the 50°F junction as a result of the Peltier effect is 103×10^{-6} watt, and the heat *generated* at the 0°F junction is 93×10^{-6} watt.

The difference between the junction temperature and the ambient temperature depends on the efffectiveness of heat transfer between the junction and its surroundings. The difference can be estimated from the pertinent heat transfer equation:

$$Q = U\,A\Delta t \qquad (3)$$

where Q is the heat transfer rate in BTU's per hour, A is the heat transfer area in sq ft. and Δt is the temperature difference between the junction and its surroundings in F°.

To estimate this temperature difference, assume an exaggerated case in which heat transfer between the junction and its surroundings is limited to one *inch* of wire on each side of the junction. For the given wire size, the total heat transfer area is 44×10^{-4} sq ft for the junction and one inch each of copper and constantan wire. According to standard texts on heat transfer[1,2] a conservative estimate for the over-all heat transfer coefficient, U, is 0.2 BTU/(hr-sq ft-°F) for the assumed conditions. Using the heat transfer rates developed above for Q, the temperature difference at the junctions from equation (3) is:

$$\Delta t_{50°} = -\frac{(3.41)\ (103 \times 10^{-6})}{(0.2)\ (44 \times 10^{-4})} = -0.40°\ \text{F.}$$

$$\Delta t_{0°} = \frac{(3.41)\ (93 \times 10^{-6})}{(0.2)\ (44 \times 10^{-4})} = 0.36°\ \text{F.}$$

In the thermocouple network of Fig. 2, the circulating current flows in opposite directions through similar junctions. This means that the temperature differences calculated above are opposite in sign. The indicated average temperature of the two junctions is then $\frac{49.60 + 0.36}{2} = 24.98°$F, whereas the true average is 25.00° F.

If the junctions were located in circulating air or in liquid, the over-all heat transfer coefficient (U) would be higher, and the temperature differences and corresponding indicated error would be smaller. Also, because current decreases with the square of the wire radius, and the heat transfer area decreases proportionately with the radius, the calculated temperature difference at a junction decreases proportionately with the decrease in wire diameter.

An analysis of any number of parallel-connected thermocouples leads to the same conclusion—namely, that the error from the Peltier effect is proportional to the temperature *span* which is being averaged by the parallel-connected couples. Thus, although any one junction may differ from its environment temperature significantly due to the Peltier effect, the average temperature of the junctions in such a parallel network differs from the average of the environmental temperatures by an amount which is negligible in practical applications.

The Thomson Effect

The Thomson effect according to Roeser[3] is proportional to $T\ d^2E/dT^2$. Since dE/dT is nearly constant over reasonable temperature spans for metal combinations commonly used in making thermocouples, the second derivative becomes extremely small in magnitude, and the Thomson-effect errors become correspondingly small. Because the Thomson effect involves heat losses from some portions of the network and heat absorption in other portions—effects which are averaged algebraically—the residual effect is considerably less than that resulting from the Peltier effect. Thus, both the Peltier and Thomson effect errors are negligible in normal applications of parallel-connected thermocouples.

Power Loss

Errors arising from power losses (i^2R losses) also occur in parallel thermocouple networks. Heat is lost throughout the network according to the resistances of the various branches and the current in each. The received signal thus is less than the signal developed at the junctions and indicated temperatures are lower than the temperatures sensed at the junctions.

In the example used to show Peltier effect errors (Fig. 2) a current of 0.0092 ampere circulated in a loop having a resistance of 0.12 ohm. This corresponds to a power loss of 10.2×10^{-6} watt, about one-tenth of the heat involved per junction as the result of the Peltier effect. The junction temperature error arising from power loss is about 0.04 F° for the particular example. This source of error also is negligible under practical conditions. If smaller thermocouple wires are used, the circulating currents and the power loss error would be reduced accordingly.

Thermocouple Variations

Kirchoff's laws provide a tool for examination of errors arising from variations among the individual thermocouples comprising the network. Briefly stated, the laws are: (1) The sum of the currents about a point is zero, if taken with due regard to sign, and (2) the sum of all the iR drops in a circuit must equal the sum of all electromotive forces.

In Fig. 1 E_C represents the cold or reference junction (or compensated junction within the measuring instrument if the latter is that type). Let us assume that: (1) The individual thermocouple junctions are at various temperatures and each couple is generating an emf with respect to E_C of $E_1, E_2, E_3 \ldots E_n$; (2) the effective combined emf output from all of the n couples is E_x, the signal input to a direct-reading temperature controller or recorder instrument; (3) the instrument uses a potentiometer circuit whose emf exactly counterbalances and opposes E_x and, consequently, there is no current flowing through the instrument or signal input circuit—that is, $i_x = 0$; (4) the resistance value of each individual thermocouple leg is $R_1, R_2, R_3 \ldots R_n$. These resistances include the contact resistances at points A and B (Fig. 1) as well as the couple junction itself, plus the resistance of the thermocouple wires located between AE_1B, AE_2B, $AE_3B \ldots$ and AE_nB, respectively.

The emf difference between E_x and E_1, $E_2 \ldots$ or E_n is equal to a voltage drop (or gain) corresponding to some $\pm iR$ value. Therefore, $E_x - E_1 = \pm i_1R_1$, and $E_x - E_2 = \pm i_2R_2 \ldots$ and $E_x - E_n = \pm i_nR_n$. Equation (4) can be derived by summation:

$$nE_x - (E_1 + E_2 + \ldots E_n) = \pm i_1R_1 \pm i_2R_2 \pm \ldots i_n R_n \qquad (4)$$

Because the algebraic sum of all currents flowing into a point must equal zero, equation (5) can be obtained:

$$\pm i_1 \pm i_2 \pm \ldots \pm i_n = i_x = 0 \qquad (5)$$

If all of the resistance values are exactly equal, then equation (4) can be simplified to equation (6) through the aid of equation (5). Also, if n (the number of parallel-connected thermocouples) is very large, equation (6) results:

$$E_x = (E_1 + E_2 + \ldots + E_n)/n \qquad (6)$$

Thus, for these two specific cases, E_x is found to be equal to the arithmetic average of the emf developed by the individual thermocouples and will give an accurate measure of the average temperature, provided, of course, that the emf vs. temperature relationship is a linear function over the temperature range considered and circulating currents are reasonably small.

In practice, the thermocouple resistances will not be exactly equal, and n will be a rather small number. It is desirable therefore to evaluate the magnitude of the error or correction term $\Sigma \pm i\ \Delta\ R/n$ when only a few couples are used in parallel and when their resistances are not exactly equal. The error or correction term will be an increment of voltage, say ΔE_x, with magnitude and algebraic sign determined by the summation of the $i\Delta R$ terms. ΔE_x can be evaluated by means of equation (7), which is derived on the basis of statistical analysis:

Table 1—Comparison of Parallel-Connected and Individual Thermocouples.

Environment and Temperature (°F approximate)		Observed emf's						
		Independent Couples				Parallel-Connected Couples		
		1	2	3	Mean	Set 1	Set 2	Set 3
Air at:	74°, 107°, 121°	0.917	1.671	2.000	1.529	1.529	1.529	1.529
Water at:	71°, 112°, 127°	0.869	1.801	2.159	1.610	1.608	1.608	1.608
Air at:	74°; Water at: 107°, 121°	0.914	1.681	1.996	1.530	1.531	1.532	1.532
Water at:	73°; Air at: 107°, 120°	0.911	1.672	1.993	1.525	1.525	1.526	1.525

$$\Delta E_x = \pm \frac{\Delta R_T \ (\overline{E} - E_{LS})}{\sqrt{n} \ (\overline{R} - \Delta R_T)} \qquad (7)$$

where: E_x represents the maximum magnitude of the emf error likely to be encountered when thermocouple resistances are not exactly equal;

n is the number of parallel-connected thermocouples;

$\overline{R}$ represents the arithmetic average resistance of the n couples where the resistance is measured between the common junction points (the actual resistance between points A and B of Fig. 1 multiplied by n);

ΔR_T represents the maximum ± resistance tolerance permitted for each couple (the maximum plus or minus small deviation from $\overline{R}$);

$\overline{E}$ is the arithmetical average emf of the individual thermocouples;

$\overline{E} - E_{LS}$ represents the maximum possible emf which can cause circulating currents to flow between the common junction points of the parallel-connected thermocouples.

Equation (7) indicates how the emf error can be made insignificant in value: (1) As the number of thermocouples in parallel is increased, the possibility of error decreases (the change is relatively large for small values of n); (2) as the wire *gage* number or length of wire is increased, the possible error decreases.

Experimental data confirm the analysis made here. Three sets of parallel-connected thermocouples were fabricated from 24-gage copper-constantan (1938 calibration) duplex wire. Wire lengths were 6′ ±½″. Each set consisted of three parallel-connected couples. Data in Table 1 compare the parallel network emf with emf's of independent individual couples under identical ambient conditions. The emf values, in millivolts, represent the arithmetic average of 12 or more observations taken at half-hour intervals. Ambient environments were stagnant air or agitated water to include poor and good heat-transfer conditions at the various junctions. Temperature range spans were approximately 40° F, as indicated in Table 1. All reference junctions were at 32° F. Theoretically, the maximum emf error for the parallel network should not exceed approximately 0.2% of the true mean value as determined by the individual thermocouples. The maximum measured error in the test set-up was approximately 0.13%.

In one application, a special refrigerated compartment uses 12 thermocouples connected in parallel and placed at strategic locations to control the average temperature of the circulating air. Fig. 3 shows the control instrumentation for the installation. The lower instrument is an electronic potentiometer-type temperature controller. A pair of 20-gage copper-constantan lead wires (approximately 100′ in length) connect this instrument to its sensing elements, the 12 parallel-connected thermocouples. The upper instrument is a time-temperature pattern controller interlocked to the temperature controller. Suitable time-temperature cams are cut for the upper instrument so that the average temperature in the room compartment can be made to cycle through the desired temperature-time curve.

There is a temperature gradient in the air stream flowing downward through the refrigerated compartment shelves. This gradient depends on storage load and operating conditions. The parallel-thermocouple average-temperature control method has proved suitable for this installation. The 12 individual couples connected in parallel are copper-constantan, No. 30-gage wire. These copper and constantan wires are 25′ in length with ±½″ tolerance. Combined theoretical errors introduced by the use of parallel couples are considerably less than 0.1F°, and average air temperature can be controlled to within ±½ F° (limited by the accuracy and response of the electronic controller and auxiliary control elements).

As an example of another practical application, thermocouples in parallel have been found useful in evaluating post-blanch cooling methods for certain food commodities. (Blanching is steam or hot-water scalding to inactivate the enzyme systems in the commodity.) Because of non-uniformity of the material in piece form (size, shape, etc.), many individual measurements are necessary to establish a reliable average cooling rate curve for the blanched commodity. Available multipoint recorders are not suitable because of their comparatively long cycles compared to the total cooling time involved. The use of thermocouples in parallel has advantages in such instances.

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3. Roeser, W. F., Thermoelectric Thermometry chapter, pages 180-205, *Temperature, Its Measurement and Control In Science and Industry*, Reinhold Publishing Co., 1941.

Acknowledgment

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ELECTRONIC

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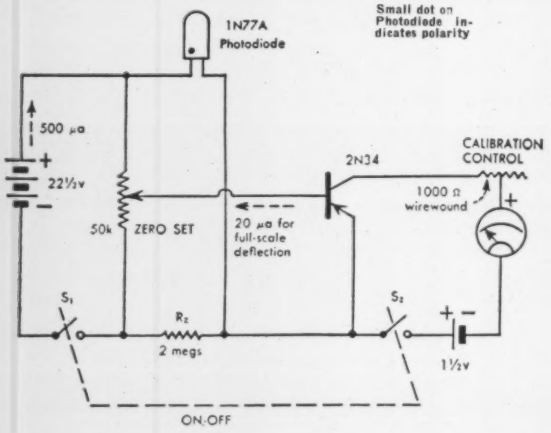
SENSITIVE LIGHT METER USES TRANSISTOR CURRENT AMPLIFIER

Most sensitive light meters use delicate microammeters for indicators. A more rugged (0-1 ma) d-c indicator is used in this circuit, driven by a type 2N34 junction transistor d-c amplifier. Circuit has been used to measure the brilliance of illuminated figures and graduations on aircraft instrument dials.

The light-sensitive element is a Sylvania 1N77A photodiode. This tiny (0.094″ diameter) germanium photodiode comes with a built-in lens, and was mounted on the tip of a probe made from the case of a plastic mechanical pencil. The 1N77A is connected in series with the 2-megohm load (R_2) across the 22½-v supply battery. When polarity is as shown, the 1N77A is operating



on the inverse (back resistance) portion of its characteristic. In the dark, this back resistance is so high that only a few microamperes of diode current flow, and the potential drop across the photodide load (R_2) is small. When the diode is illuminated, however, its back resistance is lowered and the diode passes a higher current.

When the diode is illuminated, current flows in the base-to-emitter circuit of the 2N34 transistor, producing a larger current flow in the collector circuit, through the 1-ma d-c milliameter. A nominal 20-microampere base current produces full-scale meter deflection.

The light meter is calibrated as follows:

1. Darken the photodiode and switch on the instrument.
2. Set the zero-set potentiometer (R_1) for minimum meter deflection.
3. Illuminate the photodiode with 70 foot-candles of light and adjust the calibration control (R_3) for full-scale meter deflection.

Still greater sensitivity than 70 foot-candles full scale can be obtained with a more sensitive d-c meter. Sensitivity may be decreased by shunting the meter, or by reducing the value of R_2, taking care to keep photodiode current within ratings.

Sensitivity: 70 foot-candles full scale.

Size: Instrument was built in a 3″ x 4″ x 5″ box, with pencil probe connected by flexible cable.

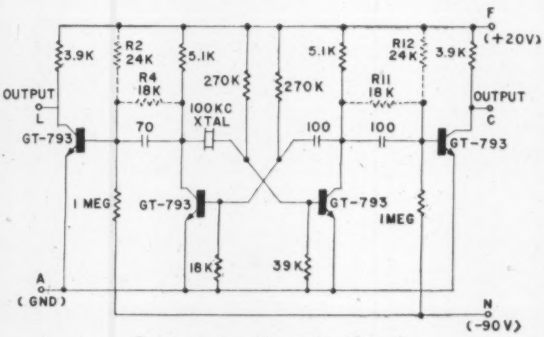
Power supply: 22½ v dc at 500 uamp; 1.5 v dc at 1.0 ma max.

Source: Booklet, 28 *Uses for Junction Tranistors*, Sylvania Electric Products, Inc., 1740 Broadway, New York 19, N. Y.

100-KC TRANSISTORIZED SQUARE-WAVE OSCILLATOR

A free-running transistor multivibrator is synchronized to 100-kc frequency by a quartz crystal in this circuit, intended for digital systems. Circuit is available in plug-in package (Model OC-103) from manufacturer.

Transistors are GT-793 NPN switching-type transistors, comprising a collector-coupled multivibrator with the 100-kc crystal replacing one of the usual coupling capacitors. Circuit resembles the conventional plate-to-grid-coupled vacuum-tube multivibrator, to which it is analogous.



C > 1 in micromicrofarads

The output transistors isolate the load from the oscillator section and provide current to drive up to ten diode gates requiring 1.1 ma each. The circuit can be changed easily to provide pulse outputs rather than square-wave.

For 5-us step outputs R4 and R11 are used, R2 and R12 are omitted; for pulse outputs R2 and R12 are used as shown and R4 and R11 omitted.

Resistors are 2/3 watt, ± 5%; capacitors are 200-volt units, ± 10%.

Output: 18-v peak to peak nominal.

Rise time: 2.5 usec.

Fall time: 1.0 usec.

Frequency stability: determined by crystal; long term

CIRCUITRY

The circuit is the heart of all electronics. Here are 4 more basic and interesting circuits. Unless marked, resistors are in ohms, capacitors in microfarads.

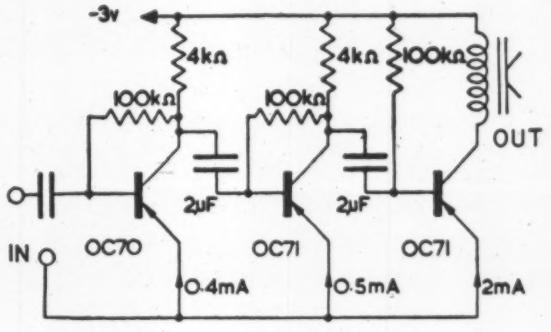
stability—less than 1 ppm per month; temperature stability—less than 3 cps deviation from −10° C to +55° C.

Power supply: 20 v at 10 ma; −90 v at 0.2 ma.

Source: Computer Control Co., Inc., 92 Broad St., Wellesley 57, Mass.

3-STAGE A-F TRANSISTOR AMPLIFIER HAS 70-DB GAIN

This 3-stage transistor amplifier uses British-made junction transistor Types OC70 and OC71. The former has a typical current gain of 30 with grounded emitter; latter has gain of 50. Both have max d-c voltage of 5 v, max collector dissipation of 25 mw at 45° C, and max ambient temperature rating of 45° C.



Gain: Over-all gain of circuit shown is about 70 db.

Frequency response: to 10 kc; coupling capacitors reduce the low-frequency response, which could be improved by increasing their value.

Power output: 1.8 mw for 10% distortion.

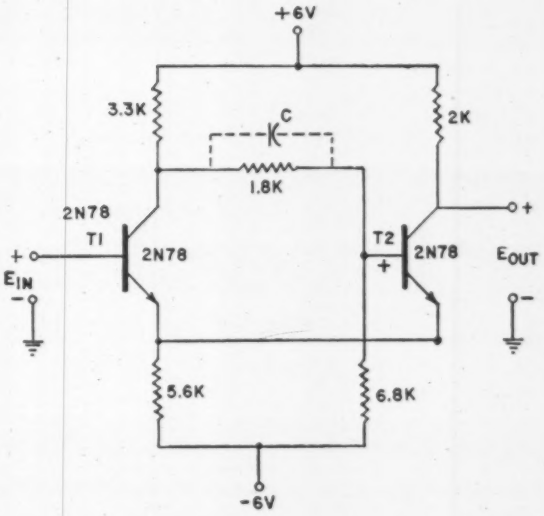
Supply: 3 v at about 3 ma.

Source: A. W. G. Wilson, Mullard Overseas Limited, Century House, Shaftesbury Ave., London W.C.2.

TRANSISTORIZED SCHMITT TRIGGER TRIGGERS ON ±0.57 VOLT

Basically a regenerative amplifier, the Schmitt trigger is often used for squaring input signals. Its output voltage has two levels; the circuit is switched between these two states depending on the input voltage. The input trigger required depends on the state—a positive trigger is required when in one state, a negative level at which switching occurs depends on the state. This transistorized circuit was designed to trigger at equal positive and negative voltage levels (0.57 volt).

Suppose that the input voltage is more negative than the −0.57-v lower trigger level. Then transistor T_1 is nonconducting and its collector is at some positive potential. Base potential of transistor T_2 is then high and



T_2 is conducting, with its output voltage at 3.6 v dc. The circuit remains in this condition when the input voltage is raised, until the upper triggering level of + 0.57 v is exceeded. The input stage T_1 then starts to conduct, its collector voltage falls, dropping the base voltage of T_2 below its emitter voltage, and cutting off current in T_2. Output voltage thus rises to the 6-v dc supply level. Output voltage remains at this level until the input signal is reduced below the −0.57-v lower triggering level.

Circuit was checked by feeding the input with a 30-cps sine wave. Output was symmetrical at 25° C ambient temperature, indicating that the upper and lower triggering levels were equal and opposite. When ambient temperature was raised to 65° C, changes in transistor characteristics produced a change in the output square wave to a 0.95:1.00 ratio of on-off times.

Input impedance at low frequencies depends on input signal level; impedance is about 1 megohm with T_1 cutoff, dropping nearly to 5.6K ohms with T_1 conducting to saturation. At higher driving frequencies, input capacitance, transistor storage, and rise and decay times would have to be considered. Capacitor C, not used at low frequency, is needed to improve switching times when the circuit is used at frequencies where rise and decay times are not negligible.

Input voltage: ± 0.57 v peak to peak threshold.

Output: 2.4 v peak to peak.

Power supply: 6 v dc at 2 ma; −6 v dc at 2 ma.

Source: Richard B. Hurley, Convair Division of General Dynamics Corp., Pomona, Calif., also *Electronic Equipment*, August 1956.

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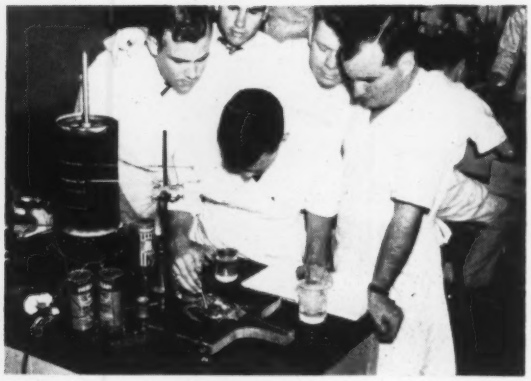

FIG. 1. SETTING UP a 100-year-old instrument can be a discouraging assignment.

Obsolete instrumentation is too often the rule in medical schools. This report describes how one medical school is replacing a 100-year-old recording technique with modern instrumentation for its students.

Instrumentation in

THE HUMAN BODY is a chemical machine, burning fuel and oxygen like any other engine. Unlike other engines, the human appraises its need and vigorously seeks it own fuel. This raw fuel, which we call food, must be received (eaten), processed (digested), and converted to more appropriate fuel for use in the cells by means of metabolism. Much of the energy so produced is devoted to motion—either to locomotion, which is movement of the body as a whole, or a variety of vital movements within the body, such as those of the digestive tract, heart, etc. All of these motions are produced by chemical motors (muscles). Essential functions, such as breathing, excretion, etc., are carefully integrated by two communication systems—one rapid by way of the nervous system, and the other slower by way of chemicals (endocrines) released into the blood stream.

The human body constantly analyses and controls these functions by elaborate servo-systems which depend largely on a great variety of remarkably selective sense organs of minute dimensions. For example, a photoreceptor in the eye has a sensitivity of a few quanta of light energy in a dimension such that approximately 150 million of these receptors would occupy one square inch.

Reaction to Disease and Disaster

It is not surprising that disease and disaster should sometimes overwhelm this well-integrated and self-protecting machine. When it does, the body marshals an impressive array of forces to restore function, or, if this is impossible, to compensate for its loss by one means or another. It is here that the physician finds his main function—assisting the natural powers of recovery. In particular, he needs to anticipate trouble and institute corrective measures before irreversible changes have taken place.

To do this he must have an accurate estimate of what is going on in the body, the degree of damage a disease has caused, and the resources available to counteract the harm. With this information he is able to estimate the degree of additional assistance required in the form of drugs or other treatment, and to evaluate its effectiveness. In former times, the doctor had only his unaided senses with which to analyze these factors. Today, to a growing degree, he has come to rely upon chemical determinations and measurements made with physical instruments to give him information that his unaided senses cannot provide.

Value of Instruments

In this field, instruments act much like the body's own sense organs. Like sense organs, they present information and not answers. The information arising from our sense organs is processed by our brain by what is known as conscious or unconscious thought. Information produced by instruments also must be processed by the physician's brain before it is of value. Here again, data-processing instruments can be of value to the medical man. We know, of course, that a great many of the simpler nervous acts, the so-called reflexes, are largely processed below the level of consciousness. Also it is probable that some of the more simple body processes, such as the level of anesthesia in an operation, can be monitored and actually controlled by instruments.

This growing application of instrumentation in medicine requires that the physician be prepared during his student years not only with an understanding

FIG. 2. PREPARING THE SMOKE chart; too often, this remains a standard procedure.

FIG. 3. SOOTED PAPER must be handled carefully.

Medical Education

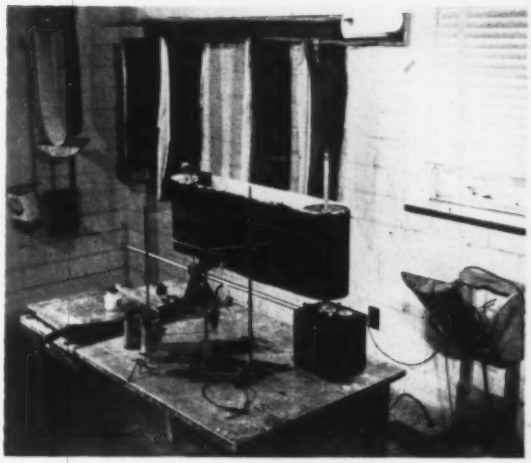

FIG. 4. RECORD CANNOT BE used until chart is coated with shellac and dried.

of the function of the body, but of the proper application of instrumentation in medicine. One feature of instrumentation is of particular importance in this regard: that is the recording of data for subsequent analysis and study, particularly when events occur too rapidly for on-the-spot analysis. This "freezing" or prolongation of the time axis permits detailed analysis and improves the opportunity to formulate and test theory.

The need has long been felt in medicine, particularly physiology (which deals with the function of the human body in health and disease), for an instrument that records a detailed history of an organ's activities through a long or short interval of time.

Just over one hundred years ago the great German physiologist Carl Ludwig introduced such an instrument into physiology by adapting James Watt's engine indicator to the study of blood pressure within living organisms. With this simple application of mechanical principles, he opened up a new approach to the study of the human body; the principle was quickly extended and a whole spectrum of studies became possible by simple mechanical contrivances.

The development of electronics made possible a greater realization of the promises of this earlier era. The electronic revolution has penetrated medical laboratories and hospitals and is transforming the possibilities of physiological instrumentation.

Dated Equipment

Despite the availability of modern electronic developments, every medical school in the world still uses the 100-year-old smoked drum with its mechanical accessories to record physiological events such as muscle pull, blood pressure, respiration, etc. Had any ordinary business so completely suffered a lack of capital reinvestment over so long a period it would long be out of business. It should be no less apparent that the medical student of the future, if he is to bring the advantages of modern instrumentation to the aid of the sick, can no longer be taught with the tools of a century ago.

The Smoked-Drum Kymograph

A brief description of the smoked-drum system will serve to illustrate its working principles. Consider an experiment in which the characteristics of heart muscle are to be studied. A good heart for this investigation is the turtle heart, and the two main objects of such an experiment are (1) timing the phases of its

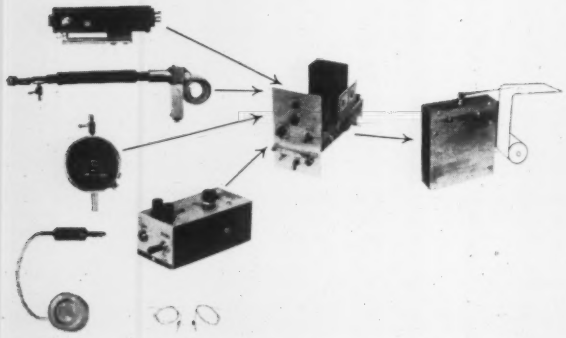

FIG. 5. TRANSDUCERS AT LEFT convert physiological phenomena into electrical signals, which are amplified (at center) and recorded (at right) in new three-channel Physiograph.

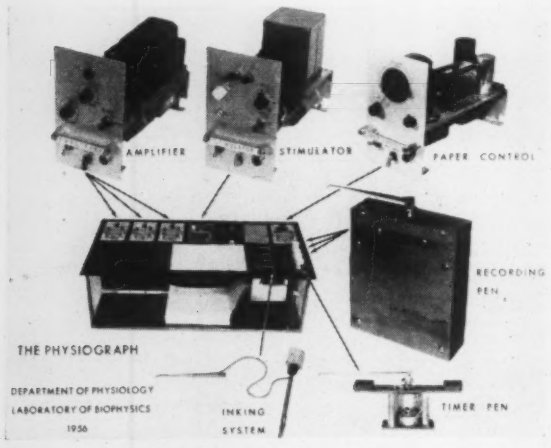

FIG. 6. STRUCTURE AND OPERATION have been kept simple so that students unfamiliar with electronic equipment can obtain accurate, understandable results.

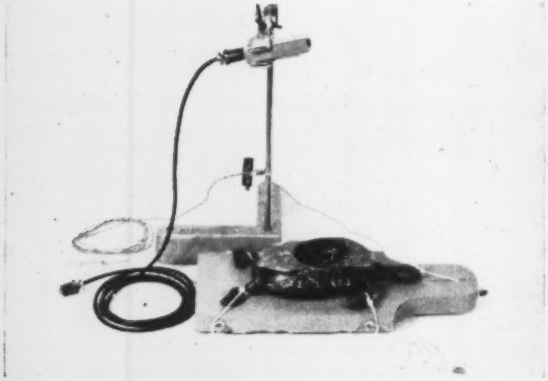

FIG. 7. MYOGRAPH connected to turtle heart.

contraction and relaxation and (2) studying the effect of increased load on the force of contraction. Fig. 1 shows a typical group of freshmen medical students connecting the turtle heart by thread to the writing levers, which touch the smoked drum as it rotates. When the chambers of the heart contract, the levers deflect and scratch soot from the passing paper. Time calibration of the record is achieved by adding a timing stylus. Obviously such a record is not permanent, nor can it be handled in its raw form. The drum must be coated with shellac before it is available for analysis.

Before the experiment can be started, the paper covering the drum must be coated with lamp-black, or "smoked" in a petroleum flame (Fig. 2). Then, with extreme care, the loop of sooted paper is transported to the apparatus (Fig. 3) and carefully installed on the drum (Fig. 4). Only after this is the system ready for adjustment of the various accessories. Two other components of the system can be seen in the background of Fig. 4; the shellac bath to fix the record and the drying racks.

This instrument, the Kymograph, is now over a hundred years old. To its credit, however, is the establishment of graphic recording which gave impetus to a new trend in physiology with the graphic method as its philosophy.

This type of instrumentation is still in widespread use today and is practically the same as in Ludwig's time. As a matter of fact, everything in Fig. 1 could have been found in a physiological laboratory one hundred years ago, except that in place of the dry cells there would probably have been the older Leclanche, Grove, or Daniell cells and, in place of the electric drive, one of clockwork. It is not intended to imply that educators are unaware of this situation. A few medical schools have attempted to remedy this situation by substituting electrosensitive papers or adding other accessories. Some have established "islands" of very elaborate equipment in the student laboratory, which can be used for demonstration purposes.

The severe operational limitations of the Kymograph are apparent and require no belaboring here. Nevertheless, two inherent limitations of the Kymograph must be recognized. First, the power to drive the recording element must be derived from the event itself. Second, the application of the Kymograph is limited to mechanical events such as muscle pull, pressure, etc. These two characteristics exclude the whole spectrum of low-energy phenomena and bioelectricity; and it is in these very fields that the most important advances have been made within recent years.

The Physiograph

This situation made necessary a new approach to instrumentation in physiology, which was proposed two years ago to the Heart Institute of the National Institutes of Health. This program proposed the development of a simple, inexpensive, general-purpose, physiological recorder which would produce records of the broadest possible spectrum of physiological phenomena.

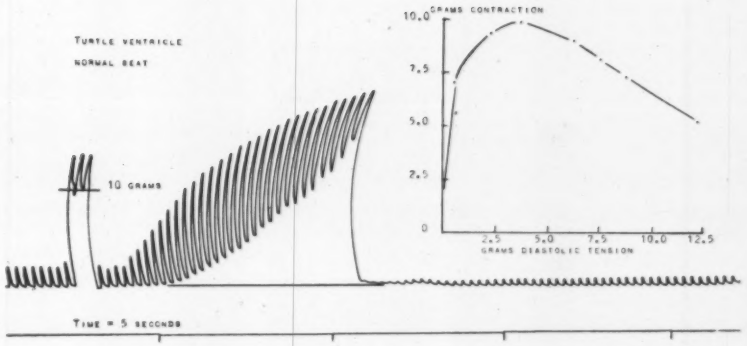

FIG. 8. RESULTS OF SIMPLE experiment illustrating Starling's law of the heart—the greater the diastolic load, the greater the force of contraction. Note, above a certain point more diastolic stretch (overloading) diminishes force of contraction.

The program was approved and thirty multi-channel recording instruments, called Physiographs*, have been developed and have been in use by freshmen and sophomore medical students in Baylor University College of Medicine for three years.

The principle of data recording is explained to the student in the following way; He is told that a data recording channel has three parts, a transducer, a processor, and a reproducer. Thus, the student understands that in order to record a physiological quantity he must use an appropriate pick-up. Once the student has this concept clearly in mind he draws the biological parallel and has no difficulty in understanding and applying the principle to record physiological events.

Important physiological events for freshmen medical students are blood pressure, muscle pull, nerve and muscle excitation by electrical stimulation, digestion, respiration, and certain phenomena associated with heart action, such as heart sounds and activity recorded by the electrocardiogram.** The combined and interrelated activity of all body organs, rather than their isolated activity, is often of greatest interest; hence an instrument to replace the Kymograph must provide the investigative facilities to cover these physiological phenomena in appropriate combinations.

The Physiographs now in operation are provided with tranducers which record these and many other events of importance. The components of a Physiograph recording channel are shown in Fig. 5. On the left can be seen a few of the various pick-ups. Some physiological events occur as electrical signals (e.g. electrical activity of the heart, brain, nerves and muscles) and a suitable electrode is the only pick-up required. These signals are small, however, and require the additional amplification provided by a preamplifier (lower left in Fig. 5). There are other important events, such as heart sounds, for which existing pick-ups have a small signal output and also require preamplification.

The Physiograph comprises three recording channels along with a stimulator and a combined paper speed controller and timer (Fig. 6). The three basic recording amplifiers occupy the first three compartments in the Physiograph cabinet. The fourth compartment houses the stimulator and the sixth holds the paper controller and timer. The fifth compartment was left blank for the addition of other accessories to be developed later. The first three recording pens, reading from top to bottom, are connected to amplifiers 1, 2 and 3. The fourth pen is the timing and signal pen and receives the timing signals of the paper control unit. Timing marks appear as downward "pips" on the fourth channel. Other events can be signalled on this channel by an upward deflection. For example, if the stimulator is used, the timer pen automatically rises when the stimulus output switch is operated.

The Physiograph thus permits three physiological events to be recorded simultaneously on the time-calibrated paper strip chart with automatic registration of any stimulation used. If some other procedure is carried out, such as an injection of a drug, this is inscribed by manually depressing a pushbutton which also pulses the timer pen. Paper speed is continuously variable from 2″/sec to approximately 2′/hr. The inking system is gravity fed and the wells are plastic squeeze-bottles.

The Physiograph has been designed and built along modular lines. Any unit can be removed after turning a key on the front panel which disengages all mechanical and electrical connections. In addition, the wiring of the units is so coded that the stimulator will work normally in any of the six compartments, the paper controller in either of the two right-hand spaces, and the amplifiers in any of the four left-hand openings. The theory behind this design was that if connections are at all possible they must be the correct connections and result in normal operation, because the operators are unskilled students.

Operation

The following are a few examples of the kind of records obtained by first-year medical students using the transducers shown in Fig. 5.

*These Physiographs were made in the Laboratory of Biophysics of Baylor Medical College. The E & M Instrument Co. of Houston, Texas, is considering making the Physiograph for interested parties.

**The electrocardiogram, a record of the electrical activity of the heart as a whole, provides information of the timing and coordination of the beat. In disease there are characteristic changes in the electrocardiogram that provide valuable diagnostic information. Taking the record is not harmful or painful.

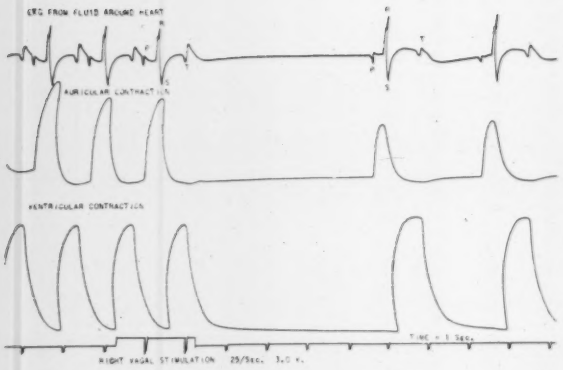

FIG. 9. INHIBITION OF THE heart action and its subsequent slower action permit separation of the individual units of each waveform complex thus aiding the study of these related functions.

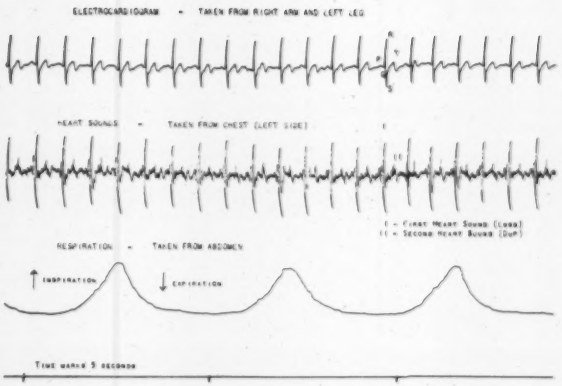
ELECTROCARDIOGRAM - TAKEN FROM RIGHT ARM AND LEFT LEG
HEART SOUNDS - TAKEN FROM CHEST (LEFT SIDE)
RESPIRATION - TAKEN FROM ABDOMEN
INSPIRATION
EXPIRATION
TIME MARKS 5 SECONDS

FIG. 10. THREE-CHANNEL RECORD of human functions provides wealth of data on interactions and cycle periods.

A single myograph (the pick-up for muscle pull) connected to a turtle heart as shown in Fig. 7 permits the record of Fig. 8 to be obtained. Each time the heart beats to expel blood, the myograph is pulled. The myograph converts this force to an electrical signal which is amplified and recorded. Thus, the amplitude of the pen excursion represents the force of each beat, and can be scaled from a calibration obtained by hanging a suitable weight from the myograph.

In this experiment, the myograph is lifted slightly between each beat to place a greater resting (diastolic) load on the heart. The heart muscle at first responds by contracting more vigorously, as shown, but soon its capacity is exceeded and the beats become weaker. The graph of contraction force versus resting tension shows that there is a maximum load which the heart can handle, above which it begins to fail, just like any other motor.

A three-channel record of nearly all of the events of the turtle heart is shown in Fig. 9. (The turtle heart, like our own, is a multi-stage pump.) This record shows the contraction of two of its stages, an auricle and the ventricle. Electrodes placed on the heart record the electrical activity of these two stages. In addition, a stimulating electrode is connected to the vagus nerve (the heart's brake). The first part of the record shows rhythmic beats of the auricle and ventricle, along with their electrical activity. In the center of the record all activity has ceased due to stimulation of the vagus nerve, signalled on the fourth channel. The order of events can be seen clearly.

An example of how this instrumentation is directly applicable to human studies is seen in Fig. 10. This record of the electrocardiogram, heart sounds and respiration was taken of a medical student. The first channel shows the human electrocardiogram taken from the right arm and left leg. Channel two is a graphic representation of the first and second heart sounds, while channel three records the respiratory movements of the abdominal region. Here, in a single record, one can calculate the heart rate, the respiratory rate and the time phases of cardiac activity by using the time scale shown on the lowest trace.

The waves of the electrocardiogram are designated P, Q, R, S, and T, and have a particular relationship to the sequence of the pumping actions of the heart, as do the heart sounds, which are transients produced mainly by the closure of the heart valves. From such a record the student can derive much valuable information.

The Program

The laboratory of physiology has twenty Physiographs serving some eighty medical students. In other words, each group of four students has its own Physiograph which is used for the first two academic years. During the first year, the students use it to examine the normal function of the various organs and parts of the body; at first singly, then later in combination. In their second year, the students study the effects of drugs on living organisms; this study is known as pharmacology. When the student arrives at his clinical years and is faced with modern instruments such as electrocardiographs, electroencephalographs, amplifying stethoscopes, etc., he already has had basic experience in instrumentation.

The Benefits

The readiness with which students have gained mastery of the instrument has been surprising. The principle of operation and assembly of units is readily understood. As evidence of this, the students soon ask for specialized pickups, such as those for measuring the percentage of carbon dioxide and oxygen so that the chemical components of respiration can be recorded and analyzed. But the outstanding feature of the program, aside from its eager reception, is that the Physiograph gathers fundamental information while subordinating itself to the purposes for which it is employed, rather than dominating the procedure.

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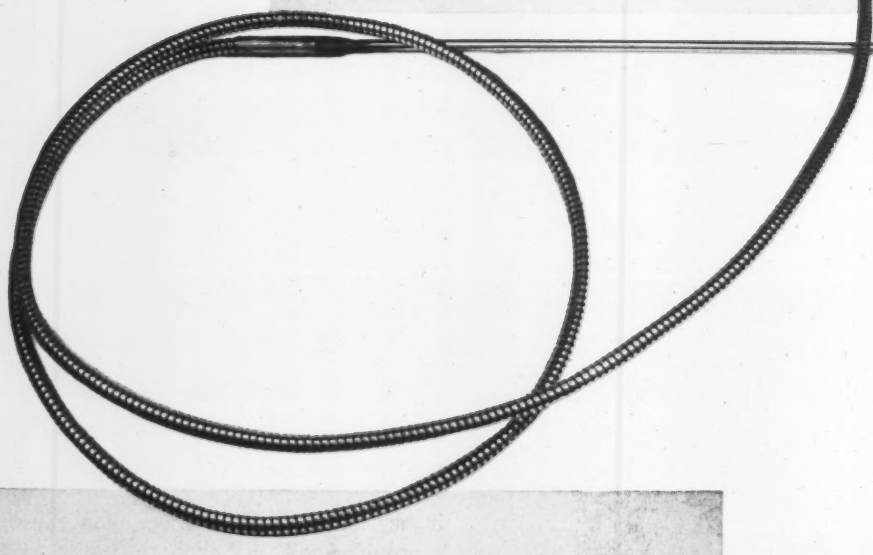

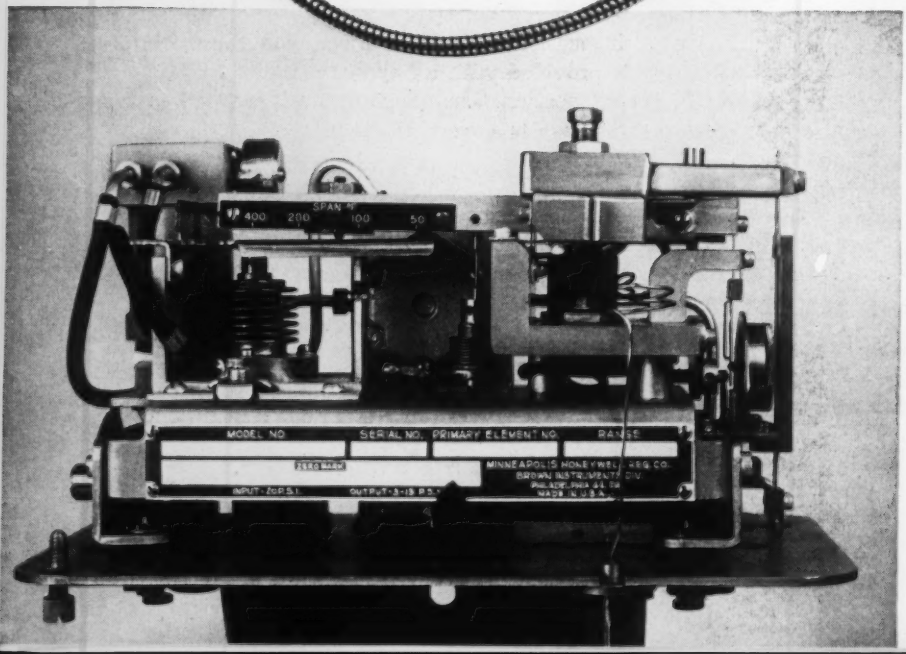

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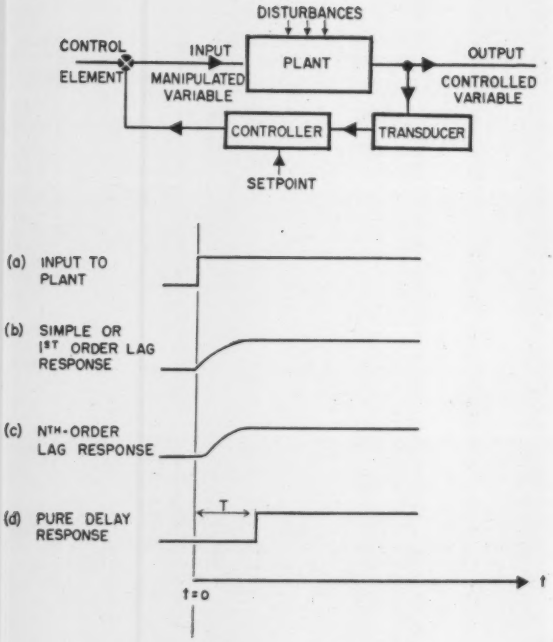

FIG. 1. TYPES of process lags.

JOHN WOOD

Tracerlab, Inc.

Controlling The

VIRTUALLY ALL PROCESSES exhibit *pure delay* or *transportation lag* (Fig. 1,d). If a step change in the manipulated variable is made at the input to the plant (Fig. 1,a), the output of the plant (controlled variable) can take several different forms —depending on the *transfer characteristic* of the plant.

Fig. 1,b indicates the familiar simple lag or transfer lag associated with a plant which is characterized by a single resistance-capacitance (RC) combination.

Fig. 1,c indicates the response of a plant with several (n) RC-type combinations in tandem and is termed an n^{th}-order lag.

Fig. 1,d indicates the response of a plant wherein the step input is exactly reproduced a certain time (T) later. This is a pure-delay plant with delay T. Fig. 3 shows the press and dryer sections of a Fourdrinier-type paper making machine where the delay can be as much as five minutes. The festoon dryer section of paper coating machines has delays up to fifty minutes.

Controller Requirements

There are, apparently, few commercially-available controllers designed specifically for the automatic control of processes involving pure delay or multi-order lags. The theoretically optimum controller for the pure-delay plant will reduce to zero a step deviation in the controlled variable from setpoint without overshoot after a time lag equal to the delay of the plant. This requires a memory with sufficient capacity to supply a delay equal to the delay in the plant. This delay is necessary to distinguish controller-initiated changes in the controlled variable from "noise" or random disturbances.[1,2] Unfortunately, the plant delays encountered in practice are of the order of minutes, whereas reasonably-priced analog memory units supply delays in the order of seconds.

The required capacity of a digital memory (such as magnetic-core shift register) which could supply the necessary delay can be easily derived. If we assume that a step deviation in the controlled variable must be detected within a time interval which is less than, or equal to, 1% of T (plant delay), then the maximum analog signal frequency which must be reconstructed from the digital data is (100/T) cps. If 1% determination of the sampled amplitude is desired, then we need a minimum of 7 bits per sample. This information must be stored in the memory at a rate of (100/T)(7) = (700/T) bits/sec. This information must be stored for a time equal to the plant

Plant delays in the order of minutes and multi-order lags in processes can not be handled by conventional control modes, and full optimal control has not yet been proved economic. Interrupted control, a new control mode, has proved efficient for these tough control situations.

Pure-Delay Plant

FIG. 2. INTERRUPTED-TYPE controller developed to fill gap between three-mode controller and optimum control of the pure-delay plant.

delay T, so we must accumulate 700/T (bits/sec) x T sec = 700 bits—independent of plant delay. This is well within the capabilities of available digital storage devices.

Unfortunately, the nature of the storage device which is used for plant delay simulation is not the most serious problem of an optimum controller. In theory, the delay in the memory unit must be equal to the delay in the plant if controller-instituted oscillations in the controlled variable are to be avoided. In practice, the plant delay is not constant; thus its actual value must be continuously determined and used to adjust the delay in the memory unit. Such a unit could be constructed, but the cost would probably be prohibitive except in rare instances.

Three-Mode Control

Of the various controllers which have been tried in the pure-delay plant, the most unsatisfactory is unfortunately the most readily available commercially. This is the standard three-mode (proportional plus reset plus rate) controller.[5,6] When such a controller is used in the pure-delay plant, the reset and rate times are adjusted until the response of the controller is sufficiently slow to prevent cycling or oscillation of the process when a disturbance acts on the plant. The net result is a control action which often is so sluggish as to have questionable utility. Even with the widest setting of the proportional band, oscillations or violent overshoot have occurred. In these cases it has been suggested that a so-called inverse-derivative unit[5,6] in series with the controller would stabilize the system. However, since the inverse-derivative unit is in essence an integrator, this serves only to make the response of the controller even more sluggish.

FIG. 3. PRESS and dryer sections of a Fourdrinier-type paper-making machine. Delay from the last press (opposite wagon) to the output of the dryers can be as much as five minutes.

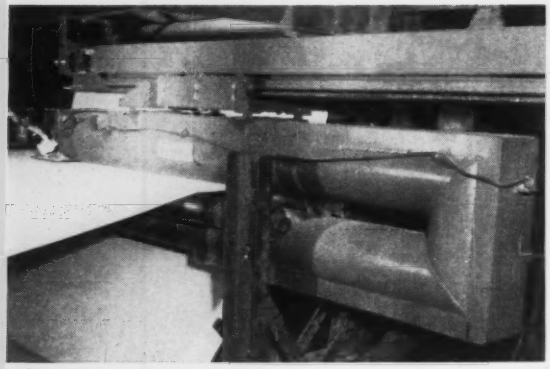

FIG. 4. SCANNING-TYPE BETA radiation gage. During the scan, the profile of the paper basis weight is displayed and its average value computed. As the gage is retracted, the controller initiates a correction proportional to the computed average.

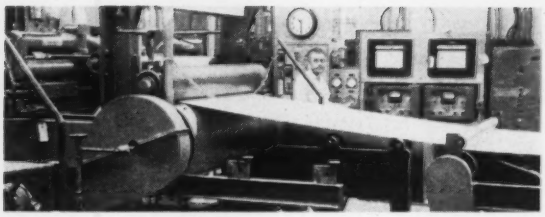

FIG. 5. INTERRUPTED-TYPE automatic control applied to plastic calender. The basis weight of the plastic, as measured by the beta radiation gage, is compared with the setpoint value by the controller. Any deviation from setpoint is corrected by operating the screw-down motors on the calender rolls.

It has been shown[1,7] that with an *optimally-adjusted* three-mode controller, the fastest possible return of a pure-delay process to the setpoint after a step disturbance in the controlled variable is *three times the plant delay*. In practice, optimal adjustment of the controller is impossible and the return to setpoint is much longer because the controller must be made inordinately sluggish, as mentioned, in order to prevent oscillation.

Interrupted-Type Controller

In order to fill the gap between the sluggish control of the three-mode controller and purely theoretical control of the pure-delay plant, a series of interrupted-type controllers has been developed (Fig. 2). An interrupted-type controller functions as follows: When a deviation in the controlled variable is detected, the controller institutes a correction proportional to the deviation and then interrupts itself (prohibits control element movement) for a time equal to the plant delay. This interruption allows the correction to travel to the gaging point. When the interruption time has elapsed, the controller is reactivated and again responds to the signal from the gage by instituting further correction if such is necessary. An interrupted-type controller can return the process to setpoint in a time equal to the delay of the plant and thus is just as fast as the theoretically optimal controller. The major difference between the theoretically optimal controller and the interrupted-type controller is that during the interruption interval the controller ignores all product variations unless they are outside a specified "alarm zone."

The interrupted-type controller has been found through widespread experience to give the most satisfactory control wherever a pure delay or multi-order lag is involved. Fig. 4 shows a scanning-type beta radiation gage installed at the end of the dryer section of a Fourdrinier paper machine where the maximum delay is 4½ minutes. During the scan, a profile of the material is displayed by the recorder and the average value is computed. When the scan is completed the gage retracts and the controller initiates a correction proportional to the computed average of the profile.

Fig. 5 shows an interrupted-type automatic control installation applied to a plastic calender.

As to future development in the control of the pure-delay plant, it seems apparent that any optimal controller—that is, a controller which continuously measures the plant transfer characteristics and tailors its settings to that characteristic—will be much more complicated and a great deal more expensive than the relatively simple interrupted-type controller described. Furthermore, items which are now standard with the interrupted-type controller, such as control-element backlash compensation, correction time, and error totalization, would also have to be engineered into such a controller.

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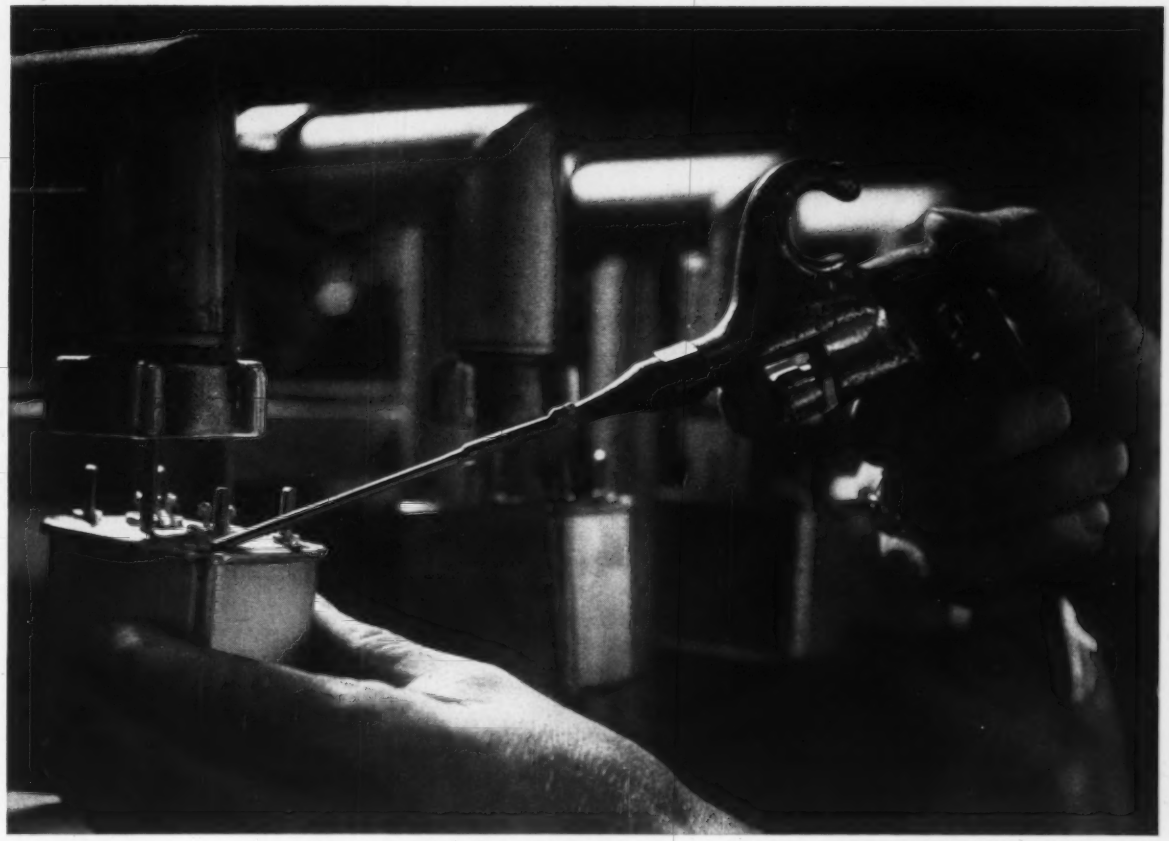

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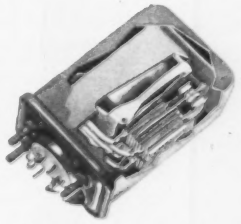

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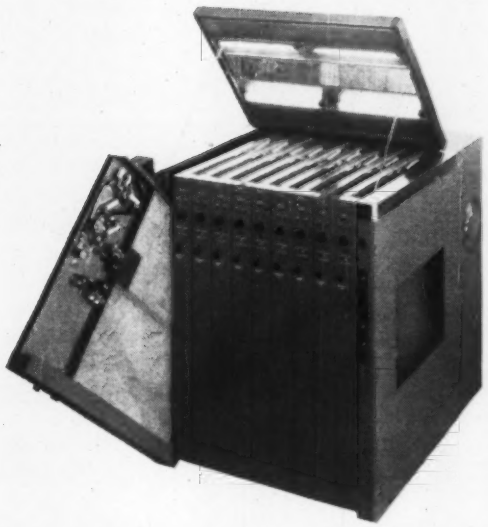

FIG. 1. MULTIPLE-ADDRESS magnetic-tape transport with cover open and one bin unit swung forward for access to the tranport mechanism.

Multiple-Address Magnetic-Tape Transport

GEORGE E. COMSTOCK, 3rd
Potter Instrument Co., Inc.

This multiple-address magnetic-tape transport system can be used with reel-type digital magnetic-tape transports, high-speed printers, digital computers, and other high-speed electronic data processing equipment as a medium-access-time, random-access memory and to provide fast sorting of digital information.

A MULTIPLE-ADDRESS magnetic-tape transport system can be used (1) for fast sorting of digital information into ascending or descending sequence of alpha-numeric block identification and (2) as a medium-access-time, random-access memory.

Description of System

Ten separate 500′ magnetic tapes are recorded upon or played back through ten magnetic record-playback heads, one for each tape. Each fourteen-track head is conservatively capable of recording and reading 200 NRZ (non-return to zero) bits per linear inch of track; 16,800,000 binary bits can be stored per tape (nearly 170,000,000 bits for the ten units). Individual tape transport mechanisms, a pair of constantly-rotating capstans with solenoid-actuated pinch roll and brake assemblies, move each tape at speeds up to 100″/sec to provide fast information storage or recovery.

Loose Storage

Economy is achieved by eliminating servo-driven reel storage; ten double-chambered bins pay out and receive tape. Absence of reel inertia makes possible high tape speeds and stopping and starting times of 3 to 5 milliseconds, permitting block handling rates approaching 100 blocks per second. Each of the ten individual bin units is attached to the cabinet base through a pivot at the lower front corner of the bin, permitting any bin to be swung forward out of the cabinet for ready access to the mechanism for loading, unloading, cleaning, and adjustment (Fig. 1). A countershaft runs concentrically through the bin mounting pivots the entire width of the cabinet. Pulleys on this shaft at each bin position provide mechanical power take-off for driving the dual capstans of the bin by interconnecting, flat, endless, woven belts.

Neutralizing Electrostatic Charge

One of the major problems encountered when tape is not held under controlled tension throughout its entire length is the accumulation of electrostatic charge on the tape. Accumulated charges attract the tape to metallic surfaces and to itself, causing considerable clinging and probable fouling of the tape in the drive mechanism.

A combination of methods has been used to eliminate this problem. First, the mechanical design of the frame and walls of the bins minimizes the area the tape can contact. Second, recording tapes having conductive films on one or both surfaces are used to minimize charge retention. Finally, provision for mounting a Krypton 85 beta radiation source within about 1/16″ of the tape plane at the point where the tape enters the FORWARD bin has been incorporated in the unit. Beta radiation ionizes the air in a small zone around the tape, discharging the accumulated electrostatic charge.

Photoelectric detectors are beside the tape on each side of the record-playback head in each bin. The recording tape is threaded between the light-sensitive cell and its light source, so that the luminous flux is normally blocked from the cell. About three feet from each end of the tape the magnetic oxide and any other opaque coating is removed for an area about ½″ wide by 1″ long. An amplifier circuit actuated by light falling on the photocell actuates a relay, which injects a stop pulse into the transport control circuits and simultaneously inhibits the transport control input line (on which pulses could arrive and cause additional motion of the tape in the same direction of travel). Thus, when each end of tape is reached, the mechanism will respond only to signals calling for reversal of tape motion.

Sorting

Decimal Sorting

An important application of a tape memory is sorting of digital information. Fig. 2 is a block diagram of a simple sorting system, in which the information is initially stored on magnetic-tape reels which can be played back on a conventional digital tape-transport unit. Let us suppose that entries have been made in chronological order on the master tape for one month, and it is desired to consolidate the information by part number in order to determine the total activity on each part for that month. It is therefore necessary to sort the blocks into an order by part numbers, usually in ascending order.

Assume that decimal digital characters are recorded in a 4-bit binary code with 1 parity-check bit, 1 clock bit, and 1 start-of-block bit—all recorded in parallel on a 7-track tape using a fixed block length of 32 characters. The first five characters in the block might represent, for example, a part number. The operation would go as follows:

All the blocks whose least significant part number digit is *1* are placed in the first bin; those whose least significant digit is *2* are in the second bin, etc. Note: Transferring tape data reverses the sequence, i.e. the original tape must start with the latest transaction in order to end up with the most recent transactions at the near end of the tape in each of the multiple-address units.

The operation is now repeated, only the next significant digit of the characteristic (part) number is examined. The result of this cycle is to place all blocks ending in 01 together, all 99's together, and similarly for all intermediate values. Repeating on the third digit in order of increasing significance results in groupings from 001 to 999. The process is repeated once for each digit position in the number group and the final result is a complete sorting of the blocks. If the characteristic being sorted against is represented by an *n*-digit decimal number, *n* sorts are required to order the list.

Equivalent programs can be evolved for other coding schemes; only the number of passes required for a complete sort will differ depending on the coding.

In the example cited, assuming a 5-millisecond reversal, the elapsed time to sort the data into the multiple-address tape handler is approximately 25 milliseconds per block, giving a block rate of 40 per second. Read-back into the master tape and initiation of the next sort cycle can be automatically sequenced by the programmer, resulting in completely automatic sorting sequence without operator attention. Faster block rates can be realized by using a shift register or tape loop to store the block information, then shifting the information into the tape at the indicated address. Another alternative uses two playback heads on the input tape handler with a built-in time delay to permit setting up the address selection with the first head, then reading in the block with the second.

These methods would increase the block rate in the example cited to approximately 100 blocks per second. This is about ten times faster than conventional punched-card sorting equipment; because the operation can be fully automatic, substantial economic gains are possible.

Collating

The items to be sorted in a data processing system are identified by a combination of straight numeric, alphabetic, or alphanumeric characters. If the total number of possible character combinations greatly exceeds the number of actual items in the system, the code is said to be a "low density" code. Under these conditions it is possible to arrange the file in ascending or descending order by the process of collation with a substantial reduction in the total number of passes required. Collation sorting also takes advantage of natural order which may occur in a file. That is, if a group of items is already in correct sequence they are kept in that sequence, whereas in decimal sorting naturally occurring order is destroyed in the initial passes.

In the simplest case, binary collations, three blocks are compared at a time; one is the last block

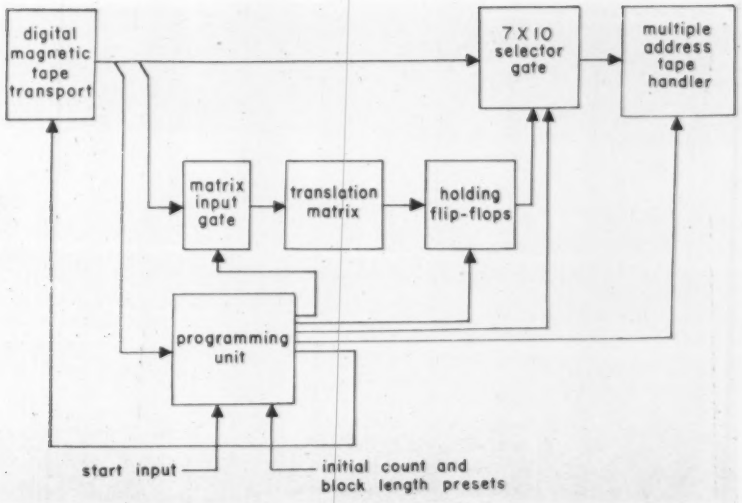

FIG. 2. BLOCK DIAGRAM for sorting.

to have been sorted and the other two are blocks from the list to be sorted. Following a set of selection rules, the appropriate block from the list is placed either with the last block or an alternate receiving location. After a complete run through the list, the tape is reversed and passes continued until the list is completely ordered. Binary collation requires a total of four storage elements, which could be four bins of the multiple-address magnetic tape transport.

Collation sorting can be accelerated at the expense of additional terminal equipment by including three or more pairs of storage locations.

The maximum number of passes through the list to complete a sorting will occur when the list is initially completely reversed.

In this case the total number of passes is:

$$n = (\log_p N)\ int$$

where n = number of passes; N = number of items in the file; p = number of pairs of bins; *int* indicates that the next larger integral number is to be taken.

Assuming a list in which each block is identified by a fifteen-digit number, we can compare binary collation, quinary collation (5 pairs of bins) and decimal sorting under two sets of conditions—dense coding and lwo-density coding:

	Dense Coding	*Low Density Coding*
N	10^{15}	10^3
n_d	15	15
n_q	22	5
n_b	35	7

Note: Number of passes required for decimal sorting is n_d, for quinary collation, n_q, and for binary collation, n_b.

These results clearly demonstrate the data processing efficiency of collation for low-density codes. The break-even point between quinary collation and decimal sorting would occur, in the fifteen-digit coding, when the list contained approximately 30 billion items!

Random Access Memory

A magnetic-tape transport has an average access time to randomly-located information blocks of approximately 1/3 the time required to pass the entire length of tape over the record-playback head. In a conventional reel-type system having 3600 feet of tape with a tape speed 75″/sec, the average access time is a little greater than 3 minutes. By dividing the tape into a number of shorter sections and operating at higher tape speed, the multiple-address transport achieves an order-of-magnitude reduction in search time. For example, with a total of 5000 feet of tape and 100″/sec speed, the ten-bin machine has an average access time of approximately 20 seconds. With 3600 feet of tape, about 14 seconds.

Another method which can speed access to a specific item is to provide two groups of information tracks on each tape. The duplicate files are recorded in the same sequence along the tape except that the first item of one group is the middle item of the second. With this data configuration, the average distance of travel to the nearest of the two positions of a given data block is approximately 12% of the tape length. In the multiple-address transport having 500 feet of tape per bin with 100″/sec speed, the average look-up time then would be about 7 seconds.

One set of read-write amplifiers can be used for a ten-bin system. When separate amplifiers are to be used for each bin it is possible to secure even faster average access time on random searching by conducting simultaneous look-ups in several bins.

Block Marker

A random access magnetic tape memory usually requires a fixed block length with fixed block positions on the tape so that old items can be replaced

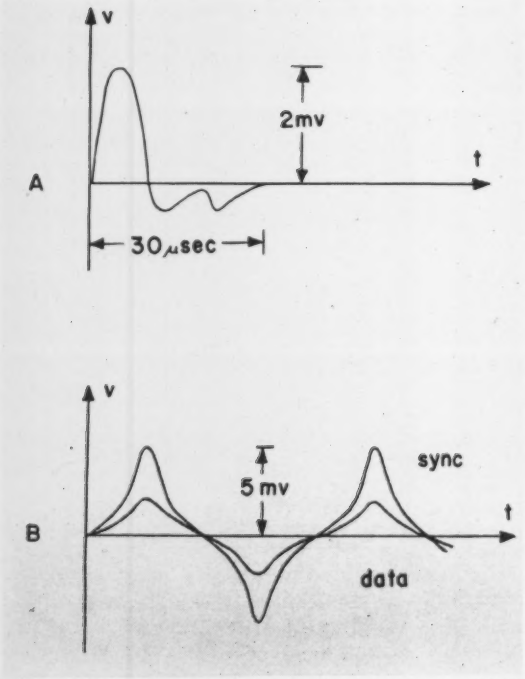

FIG. 3. TYPICAL SYNC CROSSTALK (A) and playback (B) waveforms.

by new items without interfering with adjacent blocks. In order to prevent shifting of block locations due to cumulative errors resulting from stop-start time tolerance, a pre-recorded block marker signal is used in one channel. Block recording is then initiated after detection of the block marker.

Crosstalk Minimized

Simultaneous record-playback operation is usually avoided in tape systems because of the problems of playback amplifier paralysis resulting from record-pulse crosstalk to the playback channels. The record-pulse crosstalk voltage can be several thousand times larger than normal playback signal under unfavorable conditions. In the multiple-address tape transport several design features were introduced to prevent system error due to these crosstalk signals.

The playback signal from the synchronizing track initiates the record pulse inputs to the head; thus it leads the crosstalk signal induced in the sync channel by a short interval. The remaining crosstalk control problem becomes primarily that of preventing paralysis of the sync circuits when the subsequent sync pulse is to be read.

A full-length high-permeability shield is inserted between adjacent record-playback cores to provide primary magnetic shielding. Also, sync tracks are paired and have their windings connected in series and opposing the polarity of the possible crosstalk mutual coupling from a data track.

The clock tracks are recorded so as to produce additive polarity for the sync playback signals—thereby doubling the desired output signal while unwanted external noise is partially cancelled by the differential polarity. Physical separation of the paired sync track from its information tracks is incorporated by using a record-playback head having a number of tracks equal to twice the number of data bits per character plus four; the two pairs of end tracks serve as the paired sync tracks. The data groups are named A and B. The data tracks run from the center of the head to the B sync channel end of the head, and vice-versa. For example, if 6-bit characters plus a clock bit are to be recorded, a sixteen-track head would be used. Outer two tracks on each side are the *paired* sync track (see below).

Numbering the tracks 1 thru 16 in sequence across the head, connections would be as follows:

Channel	*Polarity*	*Function*
1	+	A sync
2	−	A sync
3	+	B data
4	−	B data
5	+	B data
6	−	B data
7	+	B data
8	−	B data
9	+	A data
10	−	A data
11	+	A data
12	−	A data
13	+	A data
14	−	A data
15	+	B sync
16	−	B sync

The polarity of the *sync tracks* means the *relative polarity of crosstalk* signals induced in these windings by a record pulse applied to a data track.

The polarity of a *data track* is the relative polarity of crosstalk signal induced in a *sync winding* by a record current pulse of normal polarity applied to the data track. The alternating polarity of data windings produces a partial cancellation of the composite crosstalk signal resulting from two or more simultaneous data-record pulses. Low-capacitance coaxial cable carries the sync-track signals from the heads to a terminal board for external connections in the rear of the cabinet.

Another measure is effective in improving signal/noise in the synchronizing channels—the use of a fast-rising record-current pulse in the data channels. During RZ recording, a steady 10- to 15-ma current saturates the tape negatively, corresponding to binary "zero." A binary "one" is recorded by driving the current to + 10 to + 15 ma for a few microseconds, saturating the tape positively. Rise times of the order of 1 to 2 microseconds in the sync windings and 4 to 6 microseconds in the data tracks improve the clock signal/noise by approximately 10 db; an additional 6 db improvement results from the additive phasing of playback signals from the paired sync channel tracks, and another 6 to 12 db is gained by the differential polarity with respect to record-current induced voltages. Fig. 3 shows a typical residual crosstalk voltage waveform and, for comparison, typical sync-channel and data-channel playback signals.

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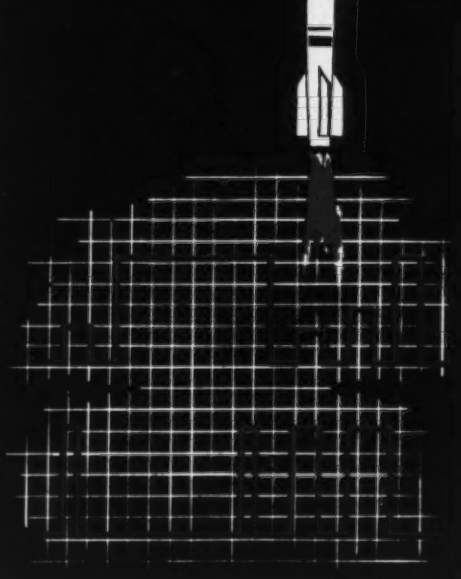

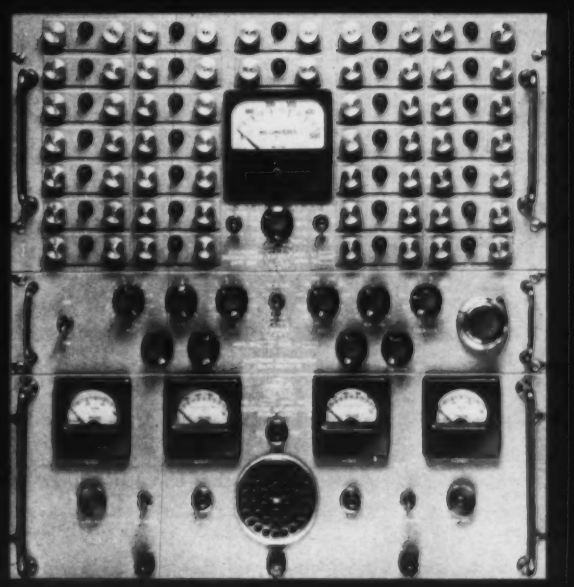

The new Arnoux Model TDS30-1 Decommutation System is completely self-contained within three chassis assemblies consisting of: Gating Unit (TOP), Pulse Selector (MIDDLE) and Regulated Power Supply (BOTTOM). The unit handles 28 channels of information and occupies only 19½ inches of panel height in a standard relay rack. Overall depth behind panel is 13 inches.

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The Arnoux Model TDS30-1 Decommutation System is compactly designed for use in airborne or trailer installed telemeter receiving stations and in portable check-out equipment.

- Miniaturization is the natural result of a new circuit design allowing the entire system to contain only 76 tubes as opposed to several hundred in competitive systems.
- Modular construction permits easy expansion of system to any desired channel capacity.
- Novel circuitry design does not reflect errors due to center frequency drift of sub-carrier oscillators, drift of discriminator D. C. output level, or tape playback speed errors.
- Built-in test selector permits visual inspection of waveforms throughout system for quick malfunction detection.
- Neon indicators on each gating unit give continuous visual indication of correct sequential operation.
- System accepts all standard IRIG inputs, either PAM or PDM, at any sampling rate from 75 to 900 per second.
- Overall linearity is within ± ½ % at maximum level. Long term level drift is within ± ½ %. Gain drift is negligible.
- Modular plug-in gating units allow quick replacement of faulty channels.
- Two spare units are maintained on standby for instant use.
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Applications of the Recording Potentiometer

The recording potentiometer is a basic tool for measuring and recording variables such as temperature, pressure, strain, etc. It can record on a round or strip chart or it can indicate the variable on a wide variety of scale forms. Closely related to the potentiometer is the bridge recorder.

GEORGE A. RUTLEDGE
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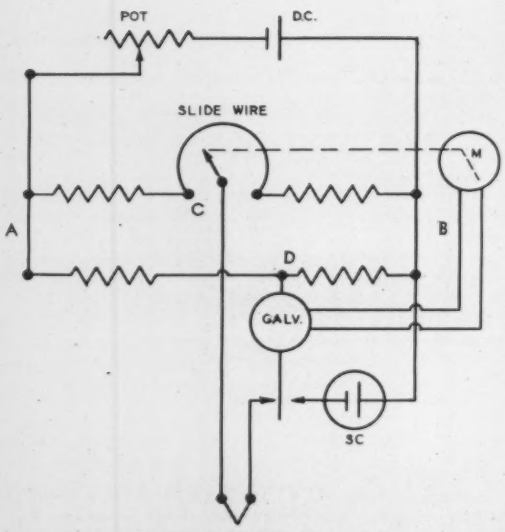


FIG. 1. BASIC potentiometer circuit.

POTENTIOMETERS receive as their input a voltage proportional to the variable to be measured (temperature, pressure, etc.), and produce an equal and opposite voltage so that *negligible current flows in the measuring circuit* when the potentiometer is balanced. This balancing out of current in the measuring circuit leads to several basic measuring advantages.

A basic potentiometer circuit is shown in Fig. 1. The unknown voltage to be measured is applied, effectively, across points C and D; the instrument applies another voltage across corners A and B. The slidewire contact can be moved (manually or automatically) so that the voltage between points C and D due to the instrument source (a battery) is exactly the same as that due to the pickup. At this point there is negligible current in the thermocouple circuit, and an instrument indicator in series with the thermocouple will show zero deflection.

Fig. 2 shows the basic circuit for a modern potentiometer. The "potentiometer" circuit at left develops a d-c signal (the *error signal*) that is fed to the "Syn-

October Meeting: Thursday, the 17th, Rio Hondo Country Club, Downey, Calif.
Feature: Charles J. O'Lone, Fielden Inst. Div., Robertshaw-Fulton Controls will discuss "Capacitance as a means of Measurement & Control."

croverter" whenever the potentiometer is not in balance. The "Syncroverter" is a chopper—that is, a high-speed switch which is flopped back and forth by a coil energized with ac so that it switches at a rate of 60 cycles per second. This rapidly reverses the polarity of the d-c "error signal," converting it into an a-c signal which is then stepped up in a transformer and amplified further. The amplified signal is placed on one phase of a two-phase motor; the other phase of the motor is energized from the a-c source. The motor then adjusts the bridge to bring the error signal back to zero, at which time the voltage from the amplifier drops to zero and the motor stops. The phasing of the amplified signal determines the direction in which the motor will run.

The Bridge Recorder

Note that the potentiometer input is a d-c emf from a sensing element. If the variable can be measured by using a resistant element, a *bridge-type recorder* can be used. Fig. 3 shows the basic circuit for an a-c bridge. Here the sensing element is simply one leg in a bridge that is excited by an a-c source. As the error signal is an a-c signal there is no need for the chopper.

The components of the potentiometer and bridge instrument can be varied or rearranged in many different ways to suit particular requirements. Often the result is neither a pure potentiometer nor a bridge; however, all have one common characteristic—they are "null-balance" instruments. In other words, they balance an internal signal against an unknown signal and arrive at a balance so that there is no current in the measured circuit. This is a valuable characteristic, because there is no (or little) current drain from the equipment producing the unknown signal. For this reason the "null-balance" instrument has become universal for a host of detecting circuits.

Typical Applications

Fig. 4 shows a combination used to record or control pH. The voltage produced between the two electrodes at the right is amplified and corrected for temperature in the pH amplifier (center), which produces a d-c voltage proportional to the pH value. The d-c signal is then recorded as pH on the potentiometer at left.

A laboratory application of a bridge recorder is illustrated in Fig. 5, which shows a gage block comparator. The sensing unit in the comparator stand (right) consists of two inductances and two capacitors arranged so that a steel armature (moved by the gaging spindle) unbalances an a-c bridge circuit. This equipment is capable of measuring and recording gage blocks to a millionth of an inch.

Fig. 6 shows one of many liquid and gas analyzers now available for industrial processes. This instrument uses the paramagnetic property of oxygen to record concentrations of as little as a few parts per million.

Fig. 7 shows an infrared gas analyzer. Nearly all gases and liquids absorb infrared radiation at different wavelengths and in amounts that depend on the concentration present. Two beams are chopped, and the flashes of one pass through a chamber containing the sample; the flashes of the other pass through a cham-

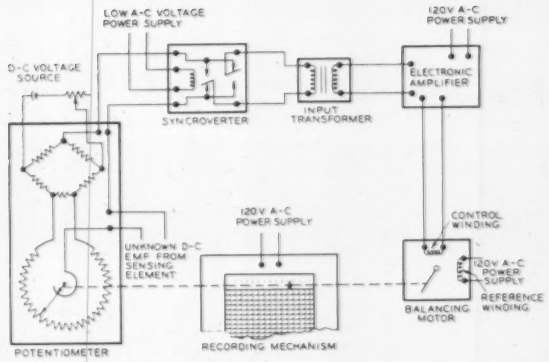


FIG. 2. CIRCUIT OF MODERN recording potentiometer. Potentiometer at left develops a d-c error signal when not in balance. Error signal is "chopped" by the Syncroverter chopper and converted in an a-c signal for amplification. Amplified signal moves balancing motor to move potentiometer circuit so that is balanced.

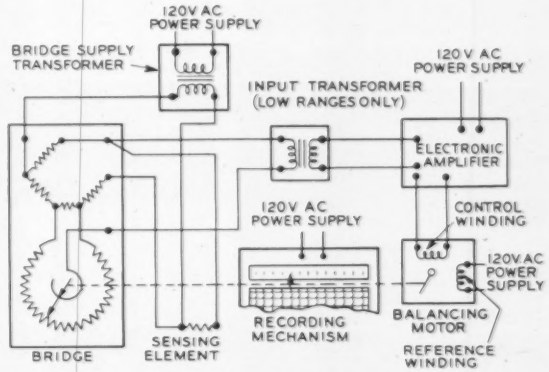


FIG. 3. CIRCUIT OF A BRIDGE-TYPE recorder is similar to the potentiometer except that the bridge is excited by a-c, and the sensing element is a variable resistance.

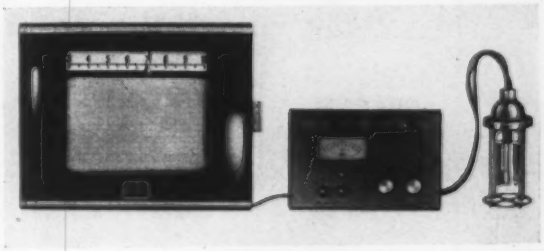
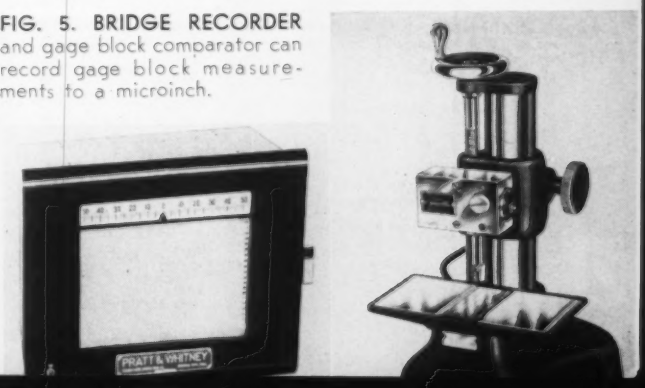
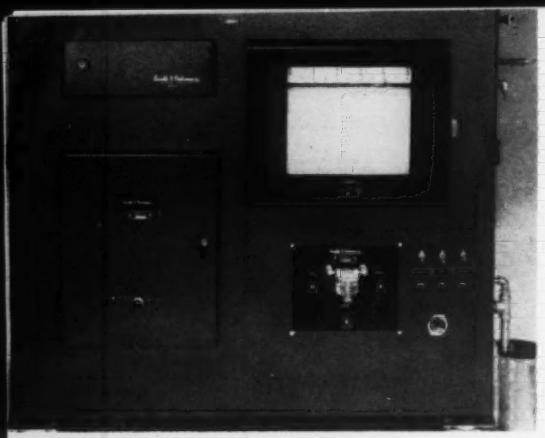


FIG. 4. USE OF RECORDING potentiometer with pH meter to record pH.

FIG. 5. BRIDGE RECORDER and gage block comparator can record gage block measurements to a microinch.





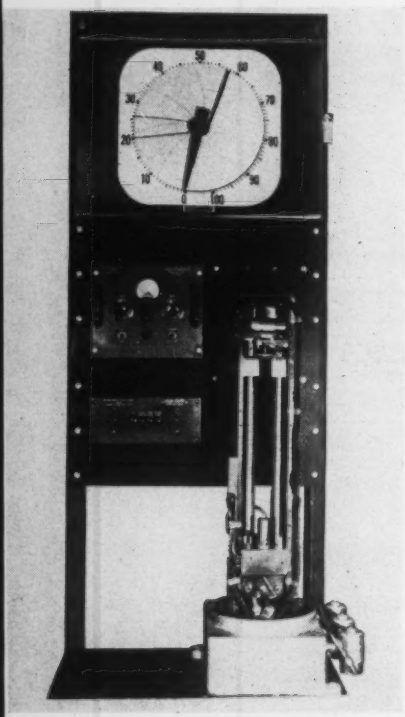


FIG. 6. THIS GAS ANALYZER uses the paramagnetic property of oxygen to record oxygen concentration.

FIG. 7. THIS GAS ANALYZER uses infrared techniques for gas analysis.

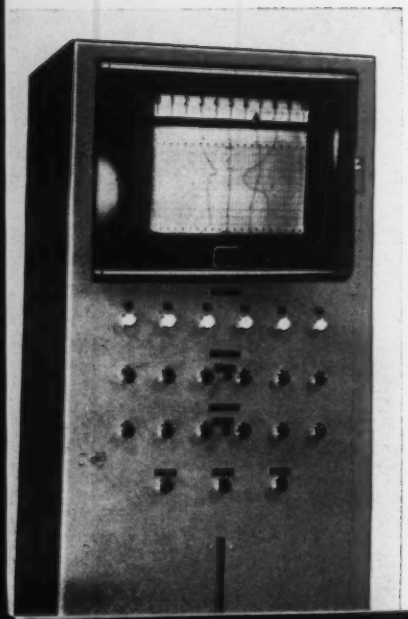


FIG. 8. THIS GAS ANALYZER can use various techniques, including catalytic combustion, thermal conductivity, and electrical conductivity.

ber holding reference material. A means is provided to detect the difference in intensity and to convert it to a d-c signal, which is recorded.

Fig. 8 illustrates a gas analyzer unit which contains a variety of systems to suit different needs. It may analyze by measurement of (1) catalytic combustion of burnable components in a gas mixture, (2) thermal conductivity of gas concentration, and (3) electrical conductivity of the resulting solution after dissolving one or more of the gaseous components in distilled water.

One recent development which makes use of a recorder for laboratory analysis is the gas chromatograph; Fig. 9 shows such a unit. The essential feature of this analytical method is the use of a column filled with an absorbent material such as activated carbon, alumina, silica gel, or a finely-divided inert solid which has been coated with a suitable high-boiling organic liquid. A carrier gas is passed through the column continuously. When a sample is injected into the carrier it is swept through the column, where the individual components are distributed between the absorbent and the carrier. If the components have different distribution-coefficients they become separated as they pass through the column, and they emerge at different times. As they emerge from the column, they can be detected at the outlet by a suitable device, such as a thermal-conductivity cell. The output of the cell is then recorded on a potentiometer. Each fraction appears on the record as a pen excursion; the *area* under each excursion is a measure of the amount of that component contained in the original sample. The method yields remarkable savings of laboratory time.

With auxiliary equipment a potentiometer can be a flowmeter of unusual rangeability—in some cases as much as 25:1. Several manufacturers make propeller or turbine-type elements such as shown in Fig. 10. Rotation speed of the propeller is directly proportional to rate of flow. A permanent magnet, located close to the propeller, produces a pulse in a pick-up coil on the outer surface of the pipe. A converter changes the frequency of these pulses to dc, which then is recorded by a potentiometer, which thus becomes a flowmeter. The same equipment without the pickup can be used as a wide-range frequency recorder.

There are recurring needs in industry for force or strain-gage recorders. This need has been partly filled by a modification of a potentiometer. As shown in Fig. 11, the voltage impressed on the bridge also is impressed across an external group of strain gages. The instrument records the amount of strain and, depending on the construction of the strain-gage cell, can record psi or total force in ounces, pounds, or tons.

A recent development of considerable interest is the gamma gage. This combination gage comprises a radioactive source, a detector cell, an amplifier, and a recording potentiometer. If the source and the detector are placed on opposite sides of some material, the signal from the detector is proportional to the mass of the material between the pickup and source; thus if source and pick-up are placed on opposite sides of a pipe in which liquid is flowing, the record indicates variations in density—without a sample line,

contact with the liquid, or reduction in pressure. Another use of this instrument is for the determination of liquid level under difficult conditions, such as in high-pressure vesssels, highly corrosive liquids, or liquids under violent agitation. Still another application is the determination of sheet thickness without contacting the sheet.

Digital Readout

The potentiometer can record almost any variable. It is sometimes used with a read-out commutator which is attached to the intrument chassis and actuated by the slidewire shaft. The commutator is connected electrically to a translator and to a tape punch or automatic typewriter. This allows the information from the potentiometer to be printed in a column. A number of items may be "read out" and printed on a multi-column sheet. This information then becomes the log sheet of a process. In some systems the log is printed in black when the variable read-out is within normal limits; off-limit readings are printed in red, and alarm systems may be operated simultaneously.

These applications show how the potentiometer can be used either individually or in combination with the output from another piece of equipment. There are a number of instances where two or more such instruments can be combined to obtain information, particularly where computing is involved. One of these is the *BTU recorder*. In this system one bridge continuously adjusts a pot whose resistance is proportional to flow; another bridge adjusts a similar pot whose resistance is proportional to temperature difference; a third instrument continuously multiplies the output of the two pots, and the resulting reading (if the temperatures and flow have been chosen correctly) is proportional to BTU.

One important application is neither bridge nor potentiometer. This is the *differential-transformer transducer and recorder*. Such a transducer makes a recorder almost a universal instrument. It may be actuated by any measured variable which can, with a suitable element, be converted into a small mechanical movement (such transducers are available for pressure, liquid level, flow, motion, etc.) In each case the primary element (helical pressure element, diaphragm element, differential-pressure unit, etc.) moves a core within a differential transformer. As shown in Fig. 12, the primary windings of this transformer (and a similar one located within the recorder) are powered with low-voltage ac from a transformer. The core of the unit within the recorder is clamped in place and the instrument, in effect, balances out the difference between the two transformers. Thus the null-balance recorder can record any variable, such as pressure, flow, etc. A variation of this development may make the differential-transformer transducer even more useful. It is a miniature recorder which takes up about the same space as a miniature pneumatic receiver.

Process plants are becoming larger, and requirements for centralizing control are becoming greater. As pneumatic transmission is limited in distance, it is surmised that this electrical system will fill a gap between the short-distance pneumatic systems and long-distance telemetering systems.

FIG. 9. USE OF RECORDER in gas chromatography.

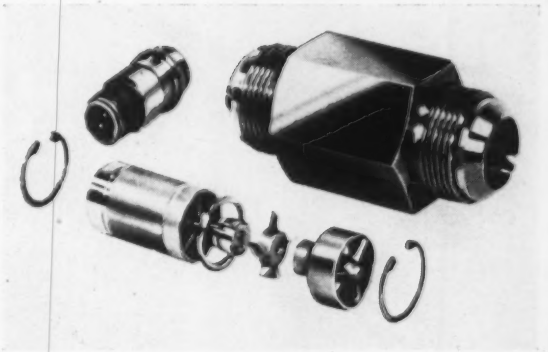


FIG. 10. TURBINE ELEMENTS produce a signal whose frequency is proportional to flow rate. Signal can be converted to dc and recorded on a potentiometer.

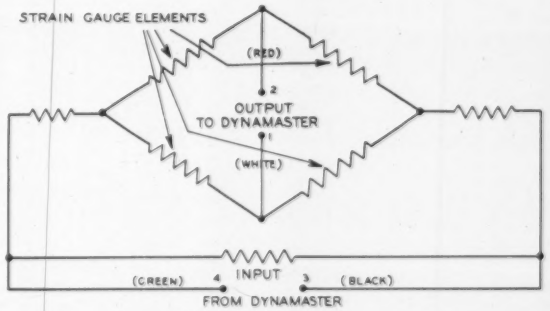


FIG. 11. TYPICAL STRAIN-GAGE pickup circuit for measurement of force, pressure, or stain.

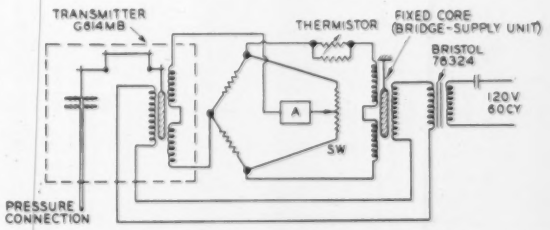
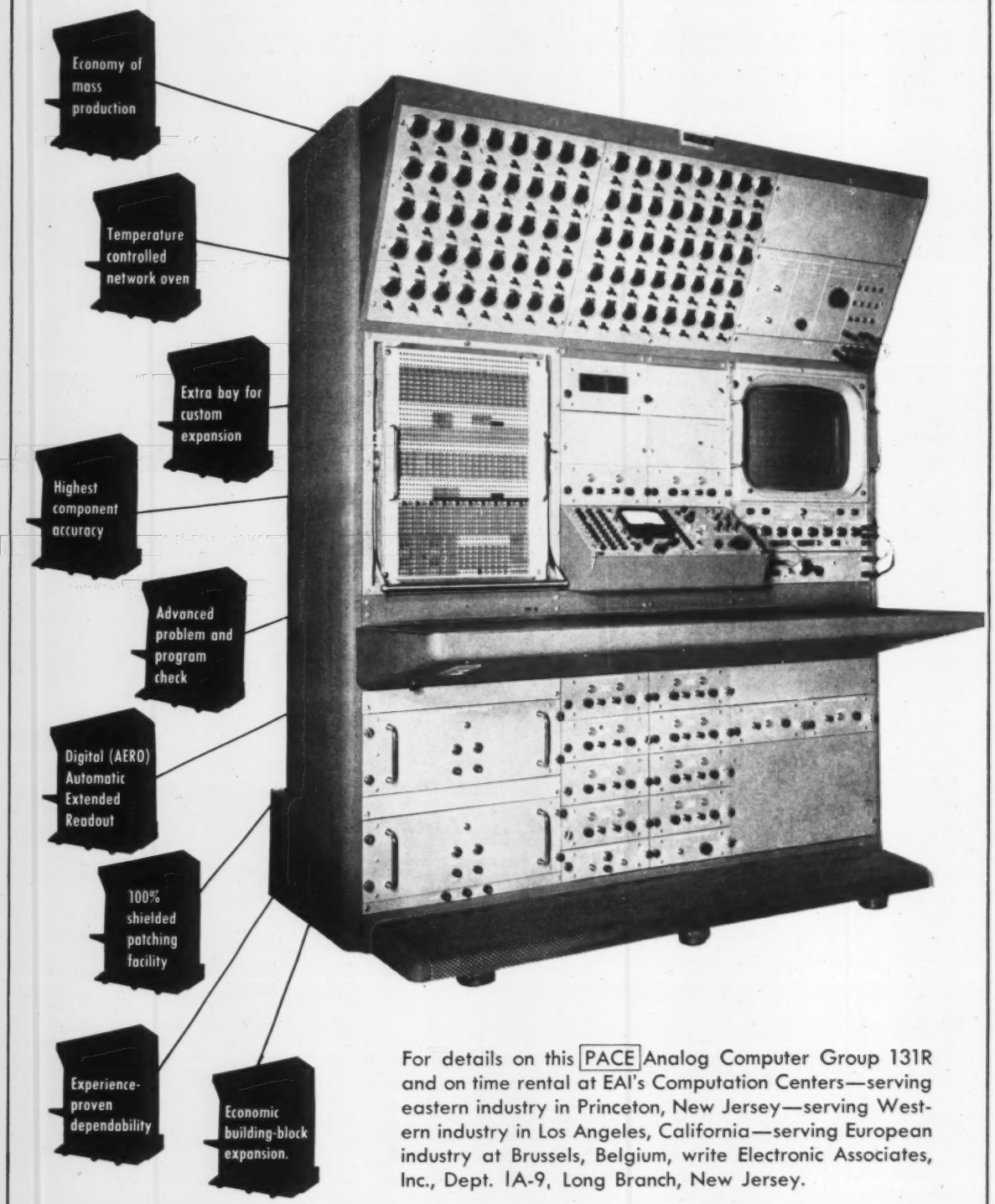


FIG. 12. USE OF DIFFERENTIAL-TRANSFORMER transducer as pressure transmitter with electrical output.



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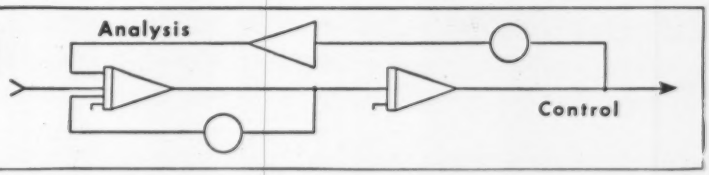

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Bits

Again we are indebted to *Hideo Mori* (Massachusetts Institute of Technology, Cambridge 39, Mass.) for most of the material in this month's *Newsletter*. Under "Pieces" we report his story of the Eastern Simulation Council meeting on Physical Simulation (flight tables, etc.), and under "Info" we pass the word about activities of the Eastern Simulation Council's Study Groups.

Pieces

EASTERN S/C MEETING OF MAY 24 ON "PHYSICAL SIMULATION"

About 80 representatives of 40 different groups attended the fifteenth Eastern Simulation Council meeting at the Westinghouse Air Arm plant at Friendship Airport (Baltimore, Maryland) to discuss "Physical Simulation."

Suarez on the Westinghouse Flight Table

Robert Bidne (Westinghouse Air Arm) welcomed the Simulation Council and introduced *Joseph Suarez*, who told about the Westinghouse flight table. Mr. Suarez first briefly explained the need for physical simulation, saying that the enormous mass of detailed computation required to design a modern system is outside the scope of conventional means of computation, so we must resort to simulation by computers. If the simulation is done in real time, actual components can be placed in the system so that the effect of their nonlinearities will be included. Among such components are gyroscopes and accelerometers which measure airframe positions, velocities, and accelerations. The best advice so far developed for properly evaluating these motions is one which duplicates the airframe motion—a "*flight table*" and the associated computer or "*flight simulator*."

The flight table described by Mr. Suarez is a platform supported by three gimbals so that it can rotate in three degrees of freedom with respect to three mutually perpendicular axes in response to yaw, pitch, and roll signals from the computer.

The Westinghouse Flight Simulator was designed for complete system simulation with much actual equipment included. Requirements were determined by forecasting future airframe performances. Primary purposes of the simulation were to study:

1. Stability
2. Threshold effects
3. Component saturation
4. Nonlinearities

The following general features were therefore necessary:

a. Capacity to handle a large volume of equipment
b. Power to handle a high inertia load
c. Smooth operation at low velocities
d. Reponse under load of 10, 15, 20 cps in yaw, pitch, and roll, respectively

Several compromises were necessary before a workable solution was reached. The responses listed under (d) above represent such a compromise; another involved gimbal rotation. It is desirable for all gimbals to have complete freedom of rotation about their respective axes, but is it necessary? Serious consideration of this particular question showed that unlimited rotation is not necessary

for the vast majority of simulation studies.

Final design of the flight table incorporated the following features:

1. No gears
2. Smoothness limited only by the feedback element
3. No slip rings
4. Simple position control with pressure feedback in the hydraulic valve
5. Responses of 10, 15, 20 cps in yaw, pitch, and roll
6. High inertia capacity (3 lb-in-sec^2, equivalent to a weight of about 185 lbs with a c.g. 2.5 inches from the roll axis)
7. Limited rotation of ± 90 degrees in yaw and pitch, and ± 120 degrees in roll.

The table has been used in a multitude of problems involving manned aircraft. In such systems it provides physical rotations as inputs to the gyros and accelerometers.

Following Mr. Suarez' talk the group discussed the relative merits of position, velocity, and acceleration flight-table control loops. Westinghouse maintained that for their purposes a position system was the best.

Roese on Westinghouse Altitude Simulator

D. W. Roese (Westinghouse) spoke next on the Westinghouse Altitude Simulator. In the simulation and performance analysis of automatic pilot systems it is desirable to generate flight-path parameters which the autopilot components are called upon to sense; one such parameter is the barometric pressure to be detected by the Altitude Controller. The Altitude Simulator is a device capable of producing barometric altitude variations along a computed flight path. The device described by Mr. Roese can be commanded by an analog computer.

The basic requirement is to control pneumatic pressure variations resulting from volume changes in a closed pressure system. This is accomplished by a feedback control system consisting of an electronic error amplifier, an electro-hydraulic valve and actuator, a variable volume pneumatic chamber, a pneumatic pressure transducer, and a second electronic amplifier for pneumatic pressure feedback.

The analog of the desired pressure variation from an established reference is introduced into the system as an electrical voltage. This input is amplified and controls an electro-hydraulic valve, which in turn actuates a hydraulic piston attached to a large bellows. The bellows varies the volume in the closed pressure system. Tied into this system is the pneumatic device under test. A transducer senses the pressure in the bellows and converts it into an electrical signal, which is fed back for comparison with the input command. Any difference between feedback and command will produce a response to reduce the error.

Associated with the system are several auxiliary items. One is a vacuum pump to bias the pneumatic system for any desired reference altitude. Another is a standard aircraft altimeter for reading the altitude. A third item is a chamber which permits establishment of an ambient pressure around a test unit.

When used for testing an altitude control unit with a volume of 100 cubic inches, at a reference pressure equivalent to sea level, the system exhibits the following characteristics:

altitude bandwidth: ± 700 feet
threshold: 1 foot
max. altitude rate: 50,000 ft/minute
threshold altitude rate: 25 ft/minute
frequency response: 10 cps

Range: Sea level to 80,000 feet (at present limited only by the altimeter). Expressed in terms of pressure instead of altitude, this is equivalent to:

bandwidth: ± 0.35 psi
threshold: 0.005 psi
maximum rate of change of pressure: 25 psi/minute
threshold rate of change of pressure: 0.0125 psi/minute

The over-all range is 14.7 psia to 0.40 psia. The use of a differential-pressure transducer as the feedback element lends itself to operation about any pressure reference within this range. It is possible to operate above as well as below atmospheric pressure. Operation above atmospheric will simulate ram air pressures useful in testing airspeed and Mach devices. Such devices may be tested as to their individual characteristics or as part of an over-all system.

Although the present design has aimed at simulating pressure altitude for a general system evaluation, its value in investigating characteristics of pneumatic pressure-sensing devices cannot be overlooked. The wide range of controllable frequencies and magnitudes possible through the use of hydraulic control elements gives it this versatility.

Wexler on Physical Simulation Study Group

Herb Wexler (AVCO, Lawrence, Mass.) spoke next, giving an interim report on the work of the Physical Simulation Study Group of which he is chariman. Topics discussed have included the following:

1. *Reasons for physical simulation.* As usual this has resulted in lively discussion. People say physical simulation is simpler and more adequately represents the system. Moreover, mathematical representation and analog simulation are not always possible. Most important (because of linearizations and other simplifications, the mathematical representation will almost always be just an approximation of the dynamic characteristics of the component.

2. *Transducers, pressure-sensitive devices, strain gauges, transformer-type pickoffs, and methods for converting outputs of transducers to suitable inputs for the computer.*

3. *Use and versatility of flight tables.* The relative merits of the single-axis versus the three-axis simulator have been considered, also possible use of a single-axis simulator to obtain three-axis information wherein coupling terms are computed by the analog computer and applied by means of torques to the single-axis simulator.*

4. *Simulation of the human operator.* An interesting point is that the response of individuals to noise is fairly constant over a large sample of individuals whereas the responses to sinusoidal or recognizable inputs varies as a function of the individual.

One of the Group's future projects will be the development of a list of

*This interesting question had been considered for some time at the Naval Air Missile Test Center before your Ed. left that organization a year-and-a-half ago. We were going to make comparative tests on the Bendix Three-Axis Flight Simulator (now installed and operative) and some locally designed high-performance single-axis tables. Hoping to be able to give my readers the word on this matter, I phoned my former colleague at NAMTC, *Willard Uplinger*, for any unclassified info he could give. Unfortunately their single-axis tables have not yet been completed, so Willard had no test data indicating that single-axis tables can be used for three-dimensional simulation. "But," he said with refreshing assurance, "we have definitely shown that a three-axis table can be used for single-axis simulation!" O tempora, o mores!

references on Physical Simulation. The Second National Simulation Conference (held April 1957 in Houston, Texas) dealt mainly with physical simulation, and it is unfortunate that the proceedings will not be published. However, a program with abstracts of the papers was published, and this is the type of reference list that the group hopes to develop.

Mr. Wexler also suggested as a possible future topic the simulation of linear forces like those acting on accelerometers. Although accelerometers are used extensively in autopilots and guidance systems, Herb said he knows of no clear-cut method of introducing the varying stimuli which the accelerometers will experience. Electrostatic, electromagnetic, and spring forces have been suggested and used, but the problem is to subject the accelerometers to these forces without appreciably modifying the instrument.

Wisnowski on Large Flight Tables

The next speaker was *W. Wisnowski* of AVCO, who described the use of a large flight table. The AVCO flight simulator is made up of two major subsystems—a three-gimbal flight table designed and built by Aircraft Armaments, Inc. (Cockeysville, Maryland), and a Mid-Century computer.

The basic requirement in the design of the AVCO flight table was that it be capable of handling a complete attitude control system assembly. This meant that the flight table would have to be quite large; the distance between center lines of the arms of the "C" gimbal is 98", and the height of the "B" axis is 82" above the floor.

The flight table is made up of three mutually orthogonal gimbals, each with complete freedom of rotation. The "A" gimbal is a cylindrical drum which is a structural member of the flight table and also the drum on which control system components are mounted in the airframe. The "B" gimbal is of truss-type construction, fabricated from welded steel tubing. A simple C frame of 10" diameter tubing is used for the "C" gimbal. Readers who would like additional information on performance requirements can get it from RAD Specification #131*.

Mr. Wisnowski pointed out that although the use of a flight table in simulation is not new, the planned usage at AVCO is. Normally a system is exposed to a specific environment, and open-loop tests are made. If a change in system performance results, an attempt is made to correlate the change in open-loop performance. AVCO plans a more direct method of environmental testing in which the system will be mounted on a cylinder from the actual airframe, which will also be used as the inner axis of the flight table. After running a check problem, environmental tests will be made with the system still assembled on this drum. The system will then be transferred back to the flight table and the check problem rerun to determine effect of system changes on closed-loop performance.

Another departure from conventional usage is the planned application to flight-test checkout. Instrumentation for the attitude control system will be mounted on the component drum and a flight test simulated. Data obtained in this simulation will then be reduced by the same methods as those to be used for the actual flight. If the information required by the systems engineers cannot be obtained by means of data from the simulated flight, then certainly it cannot be obtained from the true flight data. This will allow more intelligent selection of sampling rates and frequency responses of the various data channels. The AVCO flight table will also be used for final system testing.

McGlinn on Bendix System Simulator

E. J. McGlinn (Bendix Research Laboratories, Detroit, Mich.) described aspects of their operation of a three-axis flight system simulator over the past three years.

The complete system* consists of two basic units—12 racks of electronic equipment, and a flight table for mounting motion-sensitive hardware. Since the controls of all three axes of the table are nearly identical Ed restricted his talk to the inner or roll axis as this gives the highest performance of the three.

Originally three gimbal control systems were considered: (1) position; (2) rate; (3) acceleration. An analysis of these showed that the rate system promised superior overall performance, and it was therefore selected as control for the servos. The performance specifications were based on the simulation of the fastest missile conceivable. With a missile section of 50 pounds mounted on the roll axis, it was found that phase lags of 7° up to 20 cps could be tolerated. Furthermore, intermittent accelerations in the order of 2000 rad/sec^2 could be required with velocities as high as 50 rad/sec. Low-speed properties are also of extreme importance, as problems involving maximum speeds of only 1 rad/sec may be encountered where less than ½% speed variation can be tolerated.

A study of various servo drives showed that the stated specifications could be met with a control system incorporating a hydraulic motor and a two-stage valve. The complete system is composed of the following major components:

1. Two-stage valve
2. Hydraulic motor and reduction gear
3. Precision feedback tachometer
4. Electronic amplifiers to close the loop

Some of the more salient factors of the hydraulic and mechanical design were the use of:

1. A piston-type motor having a fixed displacement. This motor was modified so that the control valve assembly could be mounted directly on top of the motor.

2. Super-precision involute spur reduction gear, with adjustable centers to take out backlash.

3. An angular contact ball-bearing for the gears, preloaded to reduce compliance.

4. Tachometer coupled directly to the motor shaft.

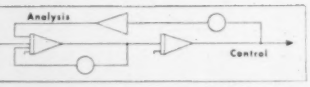
5. Ring gear face as the mount for the pay load to give high structural stiffness with minimum inertia reflected to the motor.

Experimental data from the valve and motor combination described showed that the resonant peak was 100 cps with full pay load of 0.6 lb-in sec^2.

The servo system may be considered as two closed-loop systems—the inner or valve loop, and outer or rate loop. The purpose of the valve loop is to position the hydraulic valve in accordance with DC command voltage. An electrical position pickoff is attached to the power valve providing a feedback voltage. The frequency response of the valve loop servo showed a band pass of 375 cps, and the phase shift at 100 cps was approximately 15°. Extremely smooth operation at low frequencies

*Can be obtained from RAD AVCO on request.

*See article "Flight-Table Instrumentation," by Robert Esling, *I&A*, Sept., 1956.



was demonstrated. It should be noted that in the rate open-loop system, motor and valve integration is cancelled by the feedback tachometer. To provide good low-frequency closed-loop characteristics some form of integral compensation is required. An analysis of valve loop data, including the motor and load, showed that an open-loop gain of 2500 between 0.5 and 100 cps could be used in a stable system with a closed-loop response of 600 cps. A slight amount of lead was introduced above 100 cps to improve the phase margin at 100 cps. Input to the rate servo is in the form of a 1000 cps suppressed carrier signal. To obtain a loop gain of 2500, a gain of 13,000 is required in the electronics. This gain is divided between an AC amplifier, followed by a demodulator, and a DC amplifier. A filter follows the demodulator and serves two purposes: one to filter the full wave rectified demodulation voltage and the other to shape the attenuation *vs* frequency characteristics, to act as the loop gain controller. An analysis showed that a high DC to AC gain ratio is desirable, but drift in the DC amplifier restricted the ratio to a practical value of 35 to 1.

Information (Without Theory)

Six Study Groups of the Eastern Simulation Council met during lunch before their May meeting in Baltimore, Maryland.

Members who attended the Group on "Evaluation of Analog Computer Performance" (*Bernie Loveman* of Reeves Instrument Corporation, Chairman) discussed performance requirements for computer components as follows:

A. Scale-Factor Potentiometers:
   1. Limitation due to resolution
   2. Linearity *vs* temperature, including the effect of load
   3. Linearity *vs* frequency, including the effect of capacity loading
   4. The use of fuses
   5. The use of two-speed dials

B. Factors Affecting Stability of Precision Resistors:
   1. Aging due to bobbin and casing (all resistors should be checked at least once a year)
   2. Temperature coefficient
   3. Humidity (if not protected)
   4. Voltage hysteresis
   5. Voltage shift

In connection with the talk about resistors it was pointed out that absolute accuracy—not just relative accuracy—is important. Accuracy should not be based on matched sets, because then resistors are not interchangeable and replacement in case of failure is expensive. The effect of distributed capacity on phase shift and the importance of maintaining uniform time-constants for summing amplifiers were also discussed.

C. Factors Affecting Stability of Precision Capacitors:
   1. Temperature coefficient
   2. Voltage hysteresis or soakage (polystyrene *vs* teflon)
   3. Temperature hysteresis
   4. Leakage
   5. Drift

The difficulty of making precision measurements of capacitors was considered.

First Meeting of Study Group on Process Simulation

The Study Group on Process Simulation (*E. W. James* of E. I. Dupont, Chairman) held its first meeting in May and talked about various items like control as related to the process, design *vs* operation, and mathematical *vs* empirical approaches to analysis and control. It was agreed that two important steps are required: The formulation of process equations for simulation, and the mechanization of these equations on a simulator. Representatives of both interests were present and essentially concluded that each would have some interest in the other's viewpoint.*

A process (like a refining or chemical process) was defined as a system converting one or more materials into others. It was recognized that other systems (for example, an information system) might obey the same equations and might therefore be considered.

Statements of specific interest by each man present fell into these categories:

1. Theoretical methods for attacking process simulation
2. Studies of process control by simulation
3. Special computer techniques, used and needed
4. Problem areas of importance
5. Experimental techniques for analyzing processes
6. Simulation of biological processes

Most of the men seemed to be interested in the formulation of process equations by whatever means, so it was suggested that examples be collected for consideration at future meetings. Mr. James offered to correlate reference data and present it at the next meeting together with detailed discussions of two or three from the literature.

Milton Aronson (*Instruments & Automation*, Pittsburgh, Pa.) commented on the historic importance of the first meeting of the Study Group on Process Simulation, a field whose implications have been the driving force behind the publication of the *Simulation Council Newsletter* in *Instruments & Automation*.

*Good!

Information (requested)

We recently received the following letter:

"Dear Sir:

At present we are engaged in a problem in which it is necessary to simulate a lead acid storage battery on an electronic analog computer. A search through the literature by our information service has failed to reveal any previous work along this line. In your capacity as editor of the "Simulation Council Newsletter" you may have come across some work along this line. If you have any information concerning the simulation of the battery on an analog computer, we would appreciate any help that you can give us on this problem.

K. B. Beach
Control Advance Engineering
Locomotive & Car Equipment Dept."

If anyone knows how to simulate a battery, Mr. Beach might get a charge out of it!

Computer Events

Southeastern Simulation Council

Date: Thursday evening, 26 September 1957

Place: Melbourne, Florida

Subject: "Airborne Logging Systems with Analog-Digital Conversion" Joint meeting with the IRE Professional Group on Telemetering and Remote Control

Southeastern Simulation Council

Date: Friday, 27 September 1957

Place: Radiation, Inc. Melbourne, Florida

Subject: "Analog-Digital Conversion" The man to get in touch with is Bob Marquand, Radiation Inc., P.O. Drawer 37, Melbourne, Florida.

DDA Council

Date: 15 October 1957

Place: I.A.S. Building, Los Angeles, California. Host will be Packard-Bell Computer Corp. Speakers will be Lorn Meissner and Jones V. Howell.

Symposium on Analog and Digital Computation and System Dynamics

Date: 19-20 November 1957

Place: Wright Air Development Center, Wright-Patterson Air Force Base, Ohio
There will be one combined session on topics of interest to all groups, followed by separate meetings on digital computation, analog computation, and system dynamics. For information write A. C. Robinson, Aeronautical Research Laboratory, WCRRY, Wright Air Development Center.

Simulation Councils, Inc. (annual meeting)

Dates: 9-12 December 1957

Place: Washington, D. C.
This will be held in conjunction with the Eastern Joint Computer Conference. For information write Dr. Harold Skramstad, National Bureau of Standards, Washington 25, D. C.

NEW
KEARFOTT
COMPONENTS

FOR LIGHT, MORE RELIABLE SERVO SYSTEMS

SERVO MOTORS

Standard Kearfott servo motors and servo motor-generator combinations are now available for operation with transistorized amplifiers. These units feature center tapped control phase windings rated 40 volts in series and 20 volts in parallel. Fixed phase excitation to size 8 and 10 units is 26 volts 400 cps and to size 11, 15 and 18 motors 115 volts 400 cps.

SUMMARY OF CHARACTERISTICS

Size	Stall Torque	No Load Speed	Watts Phase	Weight
8	.33 oz. in.	6200 RPM	3.4	2.1 oz.
10	.28 oz. in.	6500 RPM	3.1	1.5 oz.
11	.63 oz. in.	6700 RPM	3.5	4.5 oz.
15	1.53 oz. in.	5300 RPM	6	7.30 oz.
18	2.4 oz. in.	5300 RPM	9	12.2 oz.

TRANSISTORIZED AMPLIFIERS

A new transistorized servo amplifier suitable for driving size 8, 10, 11, and 15 servo motors is also available. This amplifier provides a 40 volt, 6 watt output. Designed to meet the requirements of MIL-E-5400 it is rated for operation over the ambient temperature range of −54°C to +71°C. Two captured screws and a recessed connector are supplied with unit. Dimensions 1 9/16" x 1 5/16" x 1 3/16" high, weight 4.7 oz.

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KEARFOTT COMPONENTS INCLUDE:
Gyros, Servo Motors, Synchros, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Indicators and other Electrical and Mechanical Components.

KEARFOTT SYSTEMS INCLUDE:
Directional Gyro Compass Systems, Three Gyro Stable Platform Systems and Inertial Navigational Systems.

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For more information circle **62** on inquiry card.

INSTRUMENTS and AUTOMATION

New Instruments

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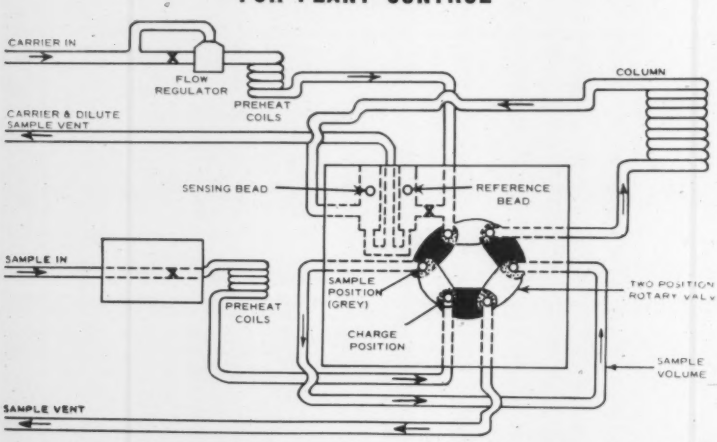
PROCESS MEASUREMENT and CONTROL

CONTINUOUS-ANALYSIS-TYPE VAPOR FRACTOMETER FOR PLANT CONTROL

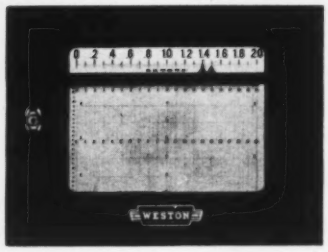


New Model 184 Industrial Vapor Fractometer extends simple lab gas chromatography technique to continuous multicomponent analyses of process streams; comprises (1) analyzer installed close to sampling point; (2) programmer unit and (3) recorder yielding bar-chart presentation. Analyzer is enclosed in an explosion-resistant housing (Class 1, Group D, Div. 1) whose upper compartment provides for thermostatting sample column, detector, sampling valve and carrier gas lines (control accuracy 0.1 C°). Outside temperature change from 10°F to 120°F causes less than 0.2 C° change in oven temperature. Programmer unit supplies timing, switching and other electrical functions for calibrating analyzer to components of a particular process stream; features operating versatility.—*Instruments Div., Perkin-Elmer Corp., Norwalk, Conn.*

For more information circle **201** on inquiry card.

RECORDER-CONTROLLER

New Model 6731 strip-chart recorder-controllers provide all modes of control including full throttling and time proportioning control, both with automatic reset and approach rate. Small case size permits mounting three in space normally occupied by two conventional units.—*Weston Electrical Instrument Corp., Newark 12, N. J.*



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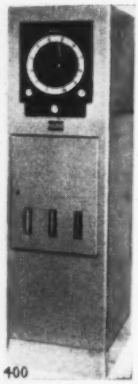
OXYGEN ANALYZER

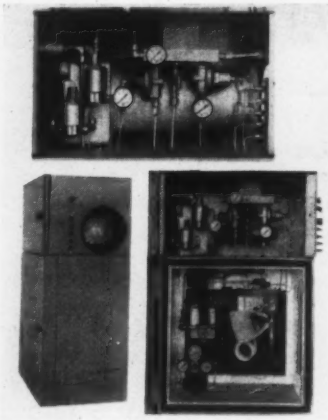


New Series 11-4000 for continuous monitoring of oxygen content in gas streams measures electrochemical change of a reagent when exposed to a gas sample containing oxygen; utilizes closed-loop cycle. Full-range sensitivity for any oxygen value from 0-50 to 0-2000 ppm. Available for indicating, recording, controlling or telemetering.—*Davis Instruments, 80 Halleck St., Newark 4, N. J.*

For more information circle **203** on inquiry card

GAS CHROMATOGRAPH

New Model 120A low-cost industrial gas chromatograph control unit and analyzer section, for continuous analysis of as many as four components of a specific gas stream, features two distinct instruments which can be placed as much as 1500 ft.



apart and maintain accurate measuring and recording. It records measurements made by new Series A Analyzer developed for use in Class I, Group D, locations.—*Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif.*

For more information circle **204** on inquiry card.

MOISTURE ANALYZER

New Model 104 NMR high-speed moisture analyzer makes quantitative determinations of moisture content in solids, syrups, cotton, tobacco, soap, geological cores, etc., in 30 sec to 4 min (as against 4 hr required by oven or similar conventional methods). Utilizing principle of nuclear magnetic resonance (NMR), it is both a research and production instrument. Once calibrated, it can be operated by an unskilled technician. Samples are not altered in any way. A permanent legally-valid chart recording of the analysis is provided.—*Schlumberger Well Surveying Corp., Box 550, Ridgefield, Conn.*

For more information circle **205** on inquiry card.

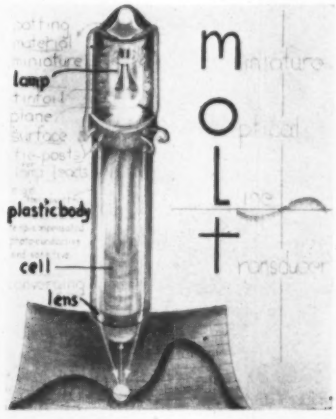
LIQUID DENSITY INDICATOR

New No. 745 indicates density of a continuously flowing process liquid; has a zero-set adjustment for original calibration under working conditions as well as adjustment for temperature-corrected sp gr reading. For use at temperatures to 220°C; ranges as small as 0.01 and as large as 0.50 sp gr; at pressures up to 125 psi.—*Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia 30, Pa.*

For more information circle **206** on inquiry card.

CURVE OR EDGE DETECTOR

New MOLT (Miniature Optical Line Transducer) weighs less than 0.5 oz and, when used as a curve follower, can be easily installed on existing *X-Y* plotters or strip-chart recorders. Combination then serves



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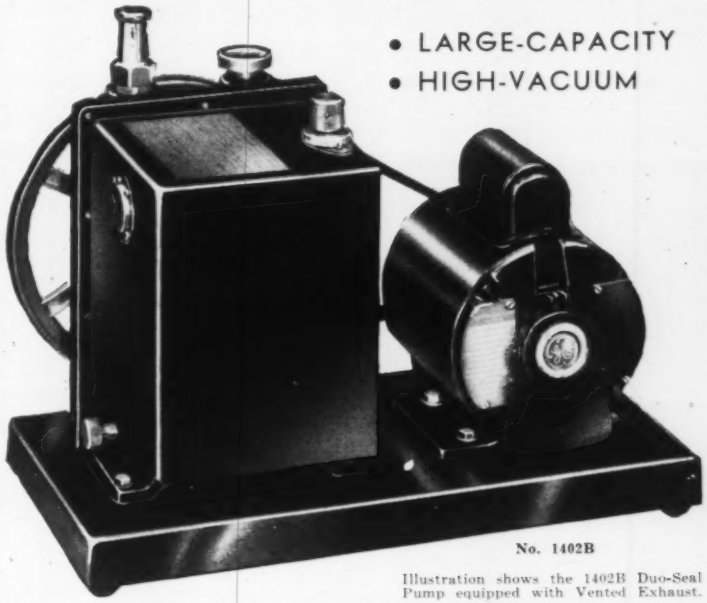
TWO-STAGE CONSTRUCTION

with **VENTED-EXHAUST**

PATENT PENDING



- LARGE-CAPACITY
- HIGH-VACUUM

No. 1402B

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GUARANTEED VACUUM — with vent closed 0.1 micron. When the vent is open, only slightly higher ultimate pressures result — usually in the range of 1 micron.

FREE AIR CAPACITY — 140 liters/minute (5 cubic feet)

★ **Vented Exhaust Permits Pumping of Most Condensable Vapors**

- **Reduces pumpdown time**
- **Reduces Number of Oil Changes**
- **Eliminates oil filters and separators**

PUMPING SPEED		
At	Vented Exhaust Closed	Vented Exhaust Open
1000 microns	110 L/M	100 L/M
100 microns	100 L/M	92 L/M
10 microns	92 L/M	68 L/M
1 micron	76 L/M	28 L/M

1402B. DUO-SEAL VACUUM PUMP, Motor Driven.
For 115 Volts, 60 Cycles, A.C. **Each, $310.00**

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DIVISION OF W. M. WELCH MANUFACTURING COMPANY

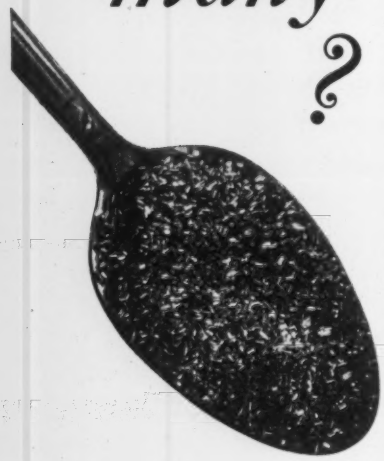
ESTABLISHED 1880

1515 Sedgwick Street, Dept. B Chicago 10, Illinois, U. S. A.

Manufacturers of Scientific Instruments and Laboratory Apparatus

For more information circle **63** on inquiry card.

how many ?



INSTRUMENT makers are using more and more Johnson pivots. Maybe you're one of them and can tell how many Johnson pivots are held in the teaspoon above.

There's a prize! No world beater, but a handy transistor portable radio to the closest guesser. In case of ties, earliest postmark will qualify.

But you needn't guess when you need precision pivots, accurately machined, scientifically hardened and polished to a metallographic finish. Direct your inquiry to Johnson for satisfaction.

Mail your estimate of the number of pivots in this regular teaspoon now to qualify for the prize. A postcard will do.

Welton V. Johnson
Engineering Company, Inc.

precision miniature parts

58 SUMMIT AVENUE

SUMMIT 6, NEW JERSEY

For more information circle **64** on inquiry card.

as an arbitrary function generator for analog computing or automatic machine tool control. Other applications: edge finding, counting, etc.—*Munro Electronic Assoc., 54 S. Main St., Mansfield, Mass.*

For more information circle **207** on inquiry card.

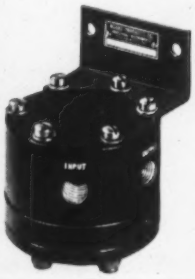
ELECTRODELESS ELECTROLYTIC CONDUCTIMETER

New instrumentation for a patented electrodeless method for measurement of electrolytic conductivity yields readings directly proportional to conductivity over "a wide range." New method supplements standard techniques and is recommended under such conditions as presence of fibers which tend to clog cells, abrasive slurries, hot highly conductive solutions, or extremely corrosive solutions.—*Industrial Instruments, Inc., Cedar Grove, N. J.*

For more information circle **208** on inquiry card.

PNEUMATIC RELAY

New Higher-Pressure Selector Relay, for use in pneumatic control circuits, selects the higher of two input



pressures and relays this higher pressure directly to next element in control circuit. Operation is without friction and time delay.—*Moore Products Co., H & Lycoming Sts., Philadelphia 24, Pa.*

For more information circle **209** on inquiry card.

FLOW-RATE, VOLUME, LEVEL

DIGITAL FLOW INDICATOR

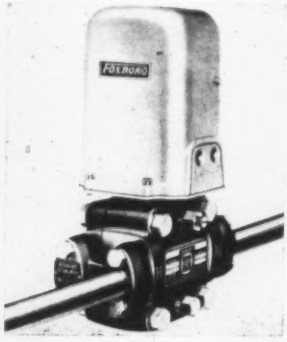
New Model 43 digital flow indicator and totalizer gives direct reading in gpm or gph, can be adjusted

to specific gravity changes to give readings in lb/hr; will give direct readings of metering-rotor speed. When used with two Pottermeters, it will indicate ratio between two flows. It samples desired information for a sample period adjustable from 0.1 millisecond to 10 seconds.—*Potter Aeronautical Corp., Union, N. J.*

For more information circle **210** on inquiry card.

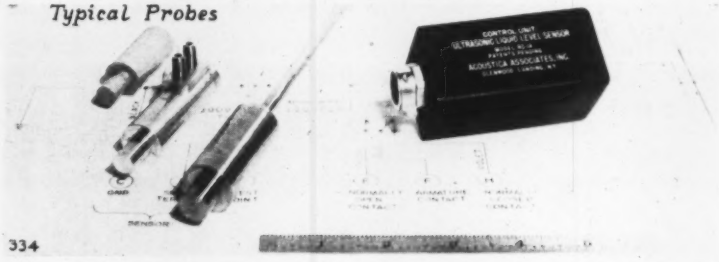
SMALL-FLOW TRANSMITTER

New Integral Orifice d/p Cell Transmitter, for small flows (minimum range 0.003 to 0.010 gpm of



clean water and similar liquids and 0.010 to 0.040 scfm of air and other gases) was developed to meet research and pilot plant needs, as well

ULTRASONIC LIQUID-LEVEL GAGING SYSTEM



New Model RC-1A light-weight liquid level point sensor for aircraft, missile fuel and oxidizer systems, as well as process control, features: no moving parts; virtually instanteous response; no spark or radiation hazard; infinitesimal power drain; wide range of operating temperatures (−200°C to 125°C).—*Acoustica Associates, Inc., Glenwood Landing, L. I., N. Y.*

For more information circle **211** on inquiry card

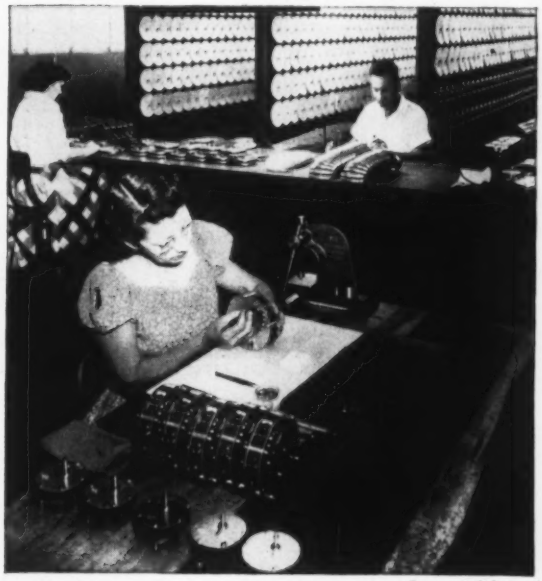
How you benefit from

New Fast Winding

ROCKWELL CHART DRIVES

SAVE TIME Whether you wind by key or crank, you will find that *new* fast winding Rockwell Chart Drives will reduce the time and effort required to service your recording instruments. Fewer turns, easier turns result from an entirely new gearing design.

REDUCE MAINTENANCE A stronger, double bushed winding pinion now minimizes one of the principal causes for chart drive failure. Powdered metal bushings throughout the new winding mechanism eliminate all need for lubrication.



FACTORY MODERNIZATION AND REBUILDING SERVICE All old model Rockwell Chart Drives returned to the factory will be modernized with the latest advancements including the new fast wind mechanism *at no additional cost* beyond the regular nominal service charge. Now is the time to upgrade your instrumentation. Ship us your old Rockwell Chart Drives for thorough rebuilding and modernization.

ROCKWELL MANUFACTURING COMPANY

INSTRUMENT DIVISION BOX 2396, TULSA, OKLA.

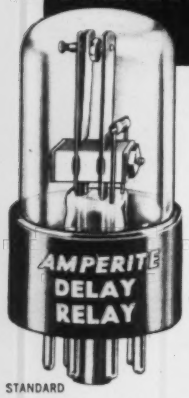
Atlanta Boston Charlotte Chicago Dallas Denver Houston Los Angeles
Midland, Texas New Orleans New York N. Kansas City Philadelphia
Pittsburgh San Francisco Seattle Shreveport Tulsa
In Canada: Rockwell Manufacturing Co. of Canada, Ltd., Toronto, Ont.

For more information circle **65** on inquiry card.

True Hermetic Sealing assures Maximum Stability

in AMPERITE RELAYS and REGULATORS

Simplest • Most Compact • Most Economical



STANDARD

MINIATURE

Thermostatic DELAY RELAYS

2 to 180 Seconds

- Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.
- *Hermetically sealed.* Not affected by altitude, moisture, or other climate changes.
- *SPST only* — normally open or normally closed.

Amperite Thermostatic Delay Relays are compensated for ambient temperature changes from −55° to +70° C. Heaters consume approximately 2 W. and may be operated continuously. The units are *most compact, rugged, explosion-proof, long-lived,* and — *inexpensive!*

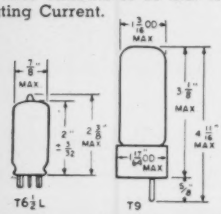
TYPES: Standard Radio Octal, and 9-Pin Miniature

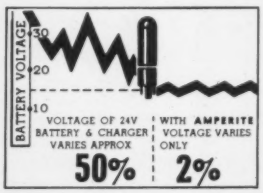
PROBLEM? Send for Bulletin No. TR-81

Also — **Amperite Differential Relays:** Used for *automatic overload, under-voltage* or *under-current protection.*

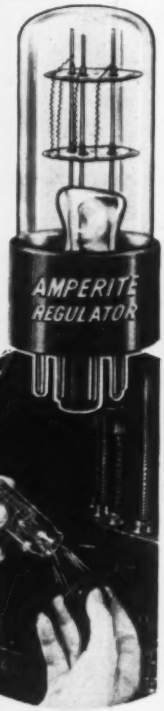
BALLAST REGULATORS

Amperite Regulators are designed to keep the current in a circuit ***automatically regulated*** at a definite value (for example, 0.5 amp.) ... For currents of 60 ma. to 5 amps. Operate on A.C., D.C., Pulsating Current.





T9 BULB



Hermetically sealed, they are not affected by changes in altitude, ambient temperature (−55° to +90° C.), or humidity ... Rugged, light, compact, most inexpensive.

Write for 4-page Technical Bulletin No. AB-51

AMPERITE CO., Inc.
561 Broadway, New York 12, N. Y.
Telephone: CAnal 6-1446
In Canada: Atlas Radio Corp., Ltd.
50 Wingold Ave., Toronto 10

Individual inspection and double-checking assures top quality of **Amperite** products.

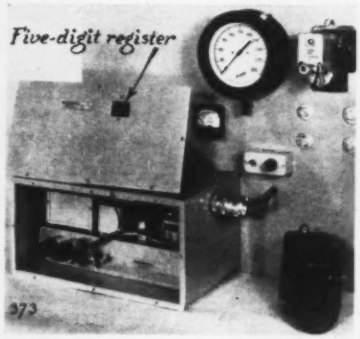
For more information circle **66** on inquiry card.

as for process operations such as ratioing small flows. Six interchangeable standard orifices, bore sizes 0.020" to 0.250".—*The Foxboro Company, Foxboro, Mass.*

For more information circle **212** on inquiry card.

FLOW METERING SYSTEM

New inexpensive electronic liquid and gaseous flow measuring system utilizes electrical signals proportional

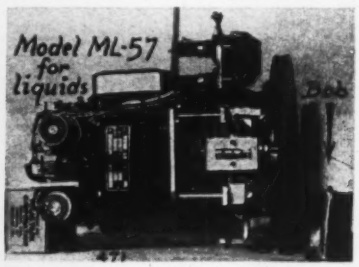


to flow rate and accumulated flow. Its computer features magnetic amplifiers, silicon diodes and transistors; has no moving parts. Accuracy within 1% of full-scale output with 20% or more flow; long-term accuracy 0.25%. Speed of response 0.03 sec for 63.2% of full-scale change. Totalized volume, registered on mechanical counter, can also be recorded on strip chart used to record flow rate.—*Computers, Inc., 2025 Harold St., Houston 6, Texas.*

For more information circle **213** on inquiry card.

LEVEL INDICATORS

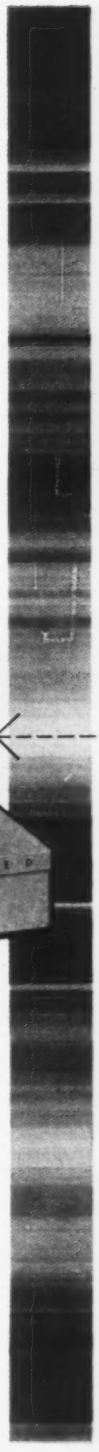
New Model ML57, for non-inflammable conductive liquids, is accurate to $\frac{1}{16}$". Principle: completion of an



electric circuit the instant a descending weighted bob contacts surface of liquid. Current is in milli-microampere range. A mechanical counter indicates level. ★Model WL57, for powdered or granular materials, utilizes change in tension in a cable supporting a weighted bob when latter contacts surface of material being measured. Bob is repeatedly raised and lowered.—*Ramsey Engineering Co., 2451 University Ave., St. Paul 14, Minnesota.*

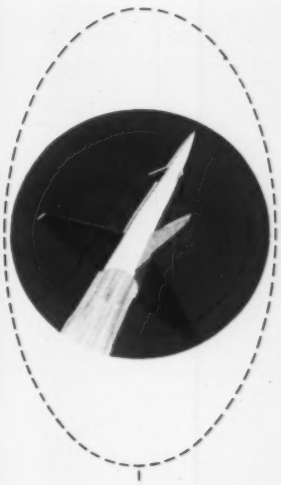
For more information circle **214** on inquiry card.

Where leakproofing is critical...

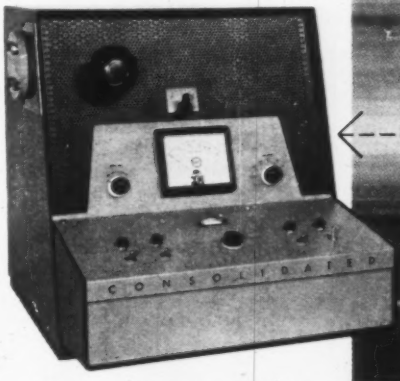


CEC's Leak Detectors

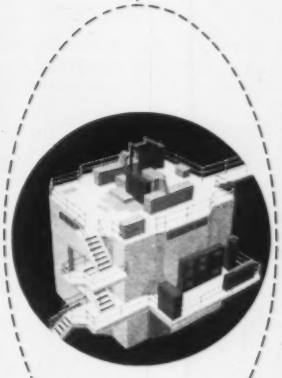
guarantee product performance



So dependable they're used to test out pressure systems of rockets and nuclear reactors. These sensitive instruments can serve *your* requirements equally well. Because CEC's Leak Detectors locate microscopic leaks *with mass-production economy,* these helium-sensitive mass spectrometers are preferred wherever vacuum or pressure leakproofing is critical. Easy, convenient operation requires no special training or experience. Find out how quickly these practical, long-life instruments pay for themselves. Contact your nearby CEC field office, or write for the Bulletins indicated.



24-210 Compact and portable, the economical 24-210 locates leaks so minute that 1cc would require 50 years to escape, or detects better than one part helium in 300,000 parts of air. Low cost with no sacrifice of reliability. Write for Bulletin CEC 1830-X27.



24-110 Ultra-sensitive, detects better than one part of helium in 2,000,000 parts of air. Recommended for requirements of large, complex, nuclear-reactor systems and high-vacuum products. Write for Bulletin CEC 1838-X12.

Consolidated Electrodynamics

300 North Sierra Madre Villa, Pasadena, California

OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

For more information circle **67** on inquiry card.

FIRST AND ONLY...

MINIATURE TWO PEN 5" RECORDING POTENTIOMETER

Transistor Amplifiers

exclusive from...

westronics® INCORPORATED

$1195.00*

THE ULTIMATE IN AN ACCURATE, READABLE, MINIATURE RECORDING POTENTIOMETER, WITH THESE ADVANCED FEATURES

- 5-inch strip chart record.
- Two pens, each traveling the full 5 inches.
- 1-second maximum balancing time.
- Table top or panel mounting.
- Panel space 9⅝" W x 8½" H
- Margin marker pens.
- Paper supply indicator front of recorder.
- Ball bearings in pen drive system.
- New concept in front set limit switches.
- 0.5% accuracy on both pens.
- Completely transistorized amplifiers, no vacuum tubes.
- MV or TC Calibration
- Minimum Span: 1 MV
- Standardization: Mercury cell.
- Simple sub-assembly type construction for easy maintenance. (Entire recorder rolls forward out of case.)

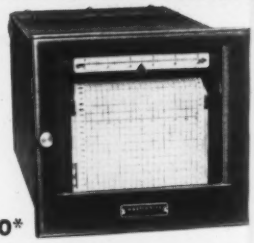
PLUS THESE OPTIONAL FEATURES:

- One front set SPDT switch and 3 SPDT back set switches each independently adjustable over the entire* range on each pen.
- Transmitting slidewires.
- Selsyn motor chart drive.
- 3 speed quick change chart drive.
- Left and/or right margin marking pens.

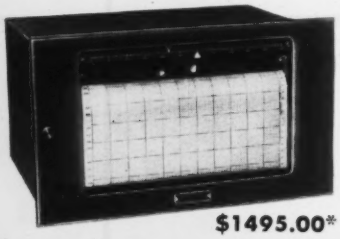
WESTRONICS RECORDING POTENTIOMETERS FOR EVERY NEED

One Pen Miniature 5" Recording Potentiometer

- 5" strip chart record.
- Continuous Automatic Standardization with electron tube amplifiers.
- Requires only 9⅝" by 8½" panel space.
- Accuracy better than 0.5%.
- One second full scale pen travel.
- Weighs less than 25 pounds.



$490.00*



Two Pen 11" Recording Potentiometer

- 11" strip chart recorder (12" overall width).
- Completely transistorized amplifiers.
- Reduced maintenance.
- Small size.
- Immediate recording . . . no warm-up time.
- Optional synchronous motor or Selsyn motor chart drive.

$1495.00*

*BASE PRICE

WESTRONICS INCORPORATED

For more information circle 68 on inquiry card.

PRESSURE and VACUUM

PRESSURE TESTER

New "Porta-Tester" bench-type hydraulic and pneumatic test stand, for use wherever pressure equipment

386

must be tested without an external source of power, can be operated by anyone without previous training. It is suitable for liquid testing up to 3000 psi; and an air connection is provided for seat-leakage testing.—*Farris Engineering Corp., 705 Commercial Ave., Palisades Park, N. J.*

For more information circle **215** on inquiry card.

PRESSURE SWITCH

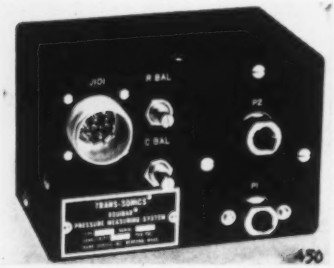
258

New GIS-8000 industrial pressure switch is 2½" in diameter; over-all height 2½". Pressure sensing chamber contains a diaphragm of material suitable for use with a variety of fluids and gases.—*Gorn Electronics Div., Gorn Electric Co., Inc., 845 Main St., Stamford, Conn.*

For more information circle **216** on inquiry card.

PRESSURE AND VACUUM MEASURING SYSTEM

New Equibar features input dynamic range of over one million (10⁻⁶ to 15 psia) and extremely deep and



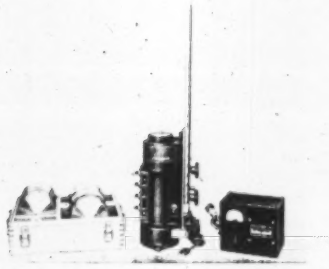
450

stable null which does not change with voltage, frequency, aging or environmental conditions. Accuracy is 2% of pressure reading, rather than of full-scale. Natural frequency is higher than 3000 cps. Sensing element consists of a stretched metal diaphragm between two capacitive electrodes.—*Trans-Sonics, Inc., Burlington, Mass.*

For more information circle **217** on inquiry card.

LAB PRESSURE GAGE

New DED-AC, electrically-operated, provides accuracy of a deadweight tester for measuring differ-

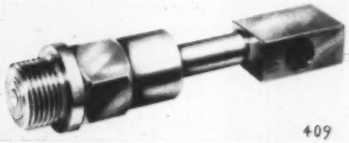


ential pressure, pressure, suction, and suction differential; functions as a transmitter for electrical recording without intermediate amplification; can be used to calibrate other gages. Ranges to 600 psig or psid.—*Manning, Maxwell & Moore, Inc., Stratford, Conn.*

For more information circle **218** on inquiry card.

HI-TEMP PRESSURE PICKUP

New pressure pickup for rocket and jet engines, high-temperature chemical reactions, etc., uses catenary dia-



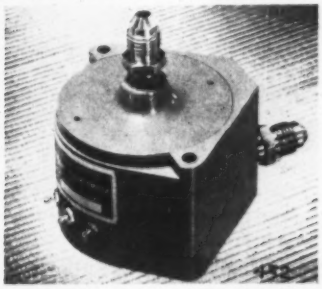
409

phragm and tubular strain gage. Water-cooling system enables diaphragm to withstand gas temperatures above 5000° F. Response flat to 10,000 cps. Models are immediately available for 0-1000 and 0-2000 psi ranges with 1% accuracy and excellent temperature compensation.—*Norwood Controls, Norwood, Mass.*

For more information circle **219** on inquiry card.

PRESSURE PICKUP

New Model 2-8-2 pressure pickup operates in temperatures from −65° F to 300° F with less than 1% devia-



tion; is of variable-resistance type; withstands vibrations of 25*G* on all axes. Overpressure up to 50% causes no shift in calibration. Available in pressures to 10,000 psia, psig or psid. —*Edcliff Instruments, P. O. Box* 307, *Monrovia, Calif.*

For more information circle **220** on inquiry card.

NEW

high level performance pressure transducers

by BOURNS

- *High vibration performance*
- *Temperature compensation*
- *Expanded measurement ranges*
- *High reliability*

An entirely new concept in pressure instrument performance combined with Bourns' experience in fine instrument manufacturing.

MODEL 409
Absolute Pressure Transducer

. . . a new design which provides extremely accurate performance characteristics. An advanced mechanism results in low vibration sensitivity for high vibration levels over all pressure ranges.
Temperature compensation and optimum material selection result in negligible temperature effect over a wide temperature environment.
Available ranges: 0-2 psia to 0-100 psia.

Write for Bulletin 409

MODEL 509
Differential Pressure Transducer

. . . a new design with the same *quality plus* features as the Model 409. The diaphragm capsules manufactured by Bourns provide exceptional hysteresis and linearity performance in addition to the low temperature error. These production instruments are assembled and tested to exacting quality standards.
Available ranges: 0-2 psi to 0-100 psi.

Write for Bulletin 509

COPR. BL

BOURNS LABORATORIES, INC.
General Offices: 6135 Magnolia Ave., Riverside, Calif.
Plants: Riverside, California—Ames, Iowa

TRIMPOT ® • LINEAR MOTION POTENTIOMETERS • PRESSURE TRANSDUCERS AND ACCELEROMETERS

For more information circle **69** on inquiry card.

Whenever the requirement is for straight alarm or limit setting, no need to pay for complex and costly instrumentation. A simple SENSITROL® relay will do the job; do it with complete reliability . . . virtually maintenance free . . . and at far lower cost. These compact relays operate direct from the output of thermocouples or other transducers, on output signals low as ½ microampere or 1 millivolt; and their positive magnetic contacts handle substantial wattage at 110 volts. No auxiliary power, vacuum tubes, or boosters needed. Available with single or double contacts, fixed or adjustable, manual or solenoid reset. For the complete story on these relays, consult your nearest Weston representative, or write for the relay bulletin . . . WESTON Electrical Instrument Corporation, Newark 12, N. J.

WESTON

Sensitrol®

RELAYS

A DAYSTROM UNIT

For more information circle **70** on inquiry card.

TEMPERATURE

PYROMETER FOR SURFACE AND AIR TEMPERATURES

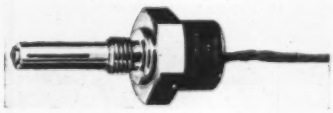
New Alnor Type 2300B Pyrometer combines functions for measuring surface temperatures and air tem-

peratures.—*Illinois Testing Labs., Inc., 420 N. LaSalle St., Chicago 10, Ill.*

For more information circle **221** on inquiry card.

RESISTANCE THERMOMETRIC CERAMIC-COATED PROBE

New Model 49132 variable-resistance temperature probe features range from −350°F to 800°F. Stand-

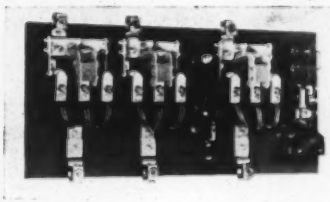


ard resistance 200 ohms at room temperature; higher resistance values available. Probes resist abrasion and environmental stresses in air or fluids; are AN threaded; withstand pressures higher than 3000 psi; are suitable for measuring jet engine inlet temperatures, etc. Repeatability is better than 0.5%.—*G. M. Giannini & Co., Inc., 918 E. Green St., Pasadena 1, Calif.*

For more information circle **222** on inquiry card.

OVEN PANELS

New ac Electric Heater Panels for control of industrial electric heaters and furnaces (including infrared, re-

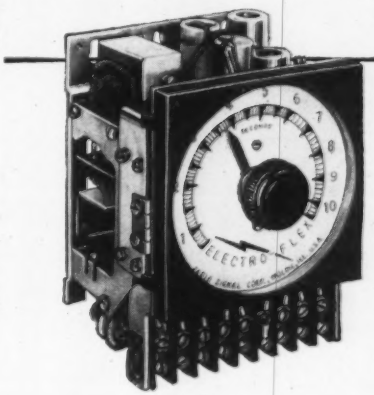


sistor and salt bath) comprise "Instrument Control" (by temperature sensing devices) and "Input Controller" (wherein contactor operates a predetermined rate of time-on, time-off to maintain temperature).—*Automatic Switch Co., Florham Park, N. J.*

For more information circle **223** on inquiry card.

NEW *EAGLE* ELECTRONIC RESET TIMER SPANS RANGE FROM .1 TO 10 SECONDS

... COMPENSATED CIRCUIT MAINTAINS HIGH ACCURACY



ELECTROFLEX

Eagle's new Reset Timer employs only two moving parts (relay armatures), achieving precise short-interval timing through a dual range electronic circuit. Timing accuracy is maintained within 2% through line voltage variations from 90 to 130v. ambient temperature changes of 52°F. to 140°F., electronic tube replacements, and vibration up to 3g.

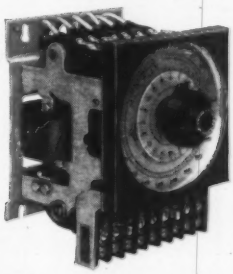
SUGGESTS NEW CONTROL IDEAS

Electroflex Dial, with precision wound potentiometer, may be mounted at the push button station with the mechanism located at a spot more convenient to wiring, installation.

PULSER

Pulsing with adjustable dwell is easily effected. Periodic output pulses may be continuously repeated with the OFF period adjustable on the dial. Pulse length (or reset time) is .050 seconds. OFF time is adjustable to 10 seconds.

COMPANION EQUIPMENT

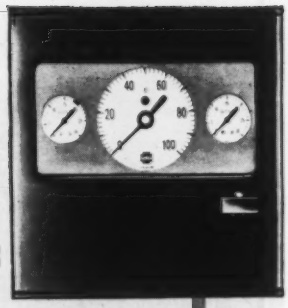


The Electroflex Timer, the Eagle Microflex Timer, synchronous motor driven for longer time intervals, and the Microflex Counter, (shown) all share the same large 4" dial, mounting dimensions, accessories and selection of enclosures to provide uniform appearance, simplify installations.

Send for new Eagle Bulletin 150. Simply write to Eagle Signal Corporation, Industrial Timers Division, Moline, Illinois, Dept. IA-957.

For more information circle **71** on inquiry card.

From
TRANSMITTER
to
RECEIVER GAUGE



unequalled USG®
sensitivity-dependability

There's never a question as to the accuracy of temperature or pressure readings when transmitted by USG Pneumatic Transmitters.

And for accurate reception of signals from remote points, there's nothing to match the sensitivity of the new USG Receiver Gauge.

Consider these features:

USG PNEUMATIC TRANSMITTERS

- Sensitivity—Within 0.1% of full scale.
- Accuracy—1% (indicating) or ½% (non-indicating)
- Designed to operate at remote points for long periods without attention. High sensitivity, linearity and freedom from dead spot assure the ultimate in control stability.

USG PNEUMATIC RECEIVER GAUGES

- Sensitivity—Within 1/10 of 1% of full scale.
- Accuracy—± ¼ of 1% of full scale.
- Diaphragms made of Ni-Span "C", a special high nickel alloy with a minimum thermal shift, even under wide variations in ambient temperature.
- Available in 3½", 4½", 6" and 8½" sizes.
- Also available are 2", 2½" and 3½" Bourdon tube actuated type receiver gauges.

USG Transmitters and Receiver Gauges are part of USG's line of creatively engineered process control instruments. The line includes gauges, pressure and temperature pilots, recorders and controllers. Write for catalogs.

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Division of American Machine and Metals, Inc.
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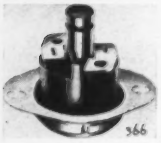
Home of the SUPERGAUGE®

MORE THAN 50,000 TYPES OF GAUGES • SUPERGAUGES • SOLID FRONT GAUGES • RECEIVER GAUGES • TEST GAUGES • RECORDERS • CONTROLLERS • TRANSMITTERS • PSYCHROMETERS • AVIATION INSTRUMENTS

For more information circle **72** on inquiry card.

MANUAL RESET THERMOSTAT



New manual-reset model of Klixon 202 Series Thermostats is available with the same mounting dimensions as in the automatic reset model; is recommended for volume production applications. —*Spencer Thermostat Div., Metals & Controls Corp., Attleboro, Mass.*

For more information circle **224** on inquiry card.

SELF-BALANCING INDICATOR

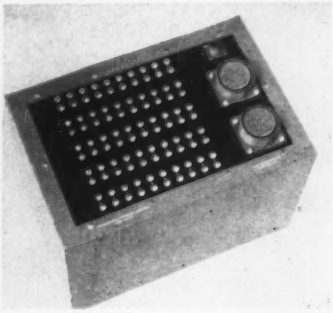
New self-balancing indicator with built-in key or push-button switches is available for thermocouples with

a null-balance-potentiometer measuring circuit and automatic cold-junction compensation; or for resistance bulbs with a null balance ac bridge measuring circuit. Scale length 34"; full-scale travel 4 sec; accuracy 0.25%.—*Thermo Electric Co., Inc., Saddle Brook, N. J.*

For more information circle **225** on inquiry card.

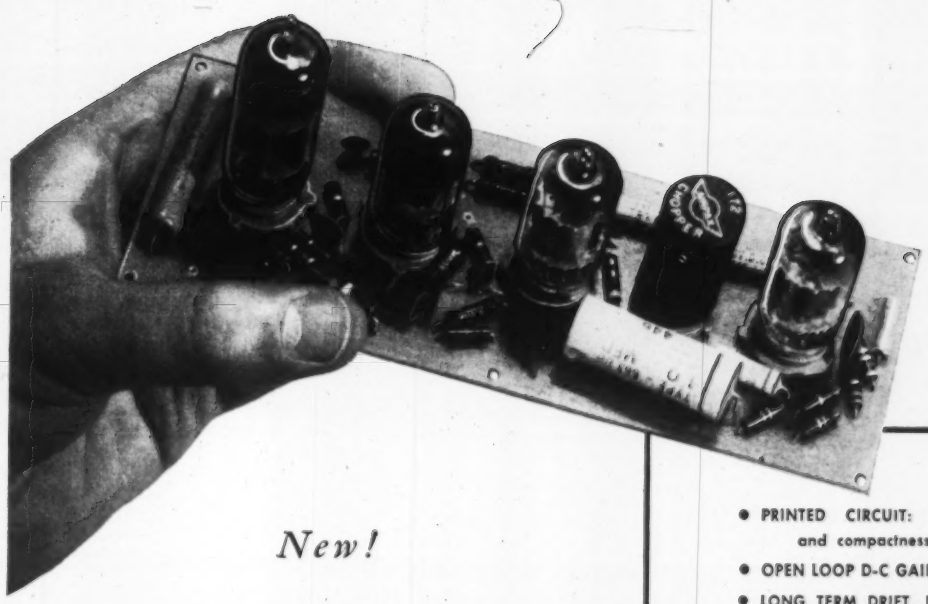
TC REFERENCE JUNCTIONS

New Bridge Stabilized Thermocouple Reference Junctions provide a controlled temperature reference for



multi-channel TC measurements. Up to 48 channels available in cabinet or rack-mounting standard models. Long-term temperature stability within ⅕ F°. Reference temperature can be set to any specified level from 25 F° above ambient to 250° F.—*Pace Engineering Co., 6914 Beck Ave., North Hollywood, Calif.*

For more information circle **226** on inquiry card.



New!

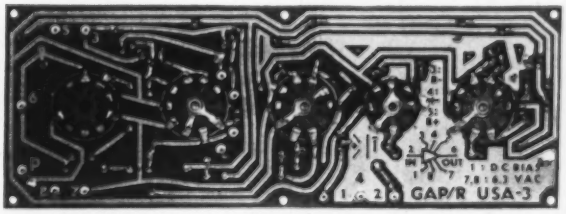
Greater System Accuracy

and Reliability with the

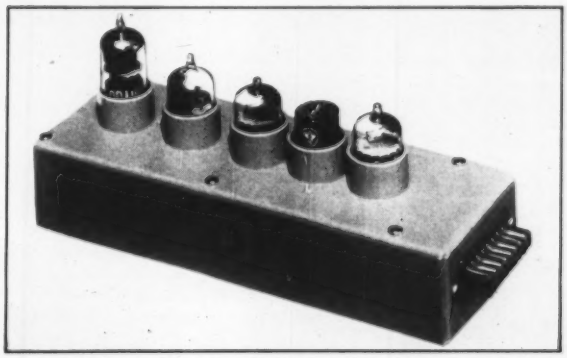
- PRINTED CIRCUIT: Economy, reliability and compactness.
- OPEN LOOP D-C GAIN: 10 million.
- LONG TERM DRIFT, NOISE and OFFSET: under 100 microvolts.
- OUTPUT VOLTAGE RANGE: ±115 volts.
- SIZE: 7" x 2½" board.
- MOUNTING: Any convenient method.
- PRICE: $95.00.

PHILBRICK *PRINTED CIRCUIT* AMPLIFIER

Model USA-3



Underside of Model USA-3 showing printed circuit, amplifier connection scheme, and connecting terminals.



Model USA-3 showing one of the several types of modular packaging available at extra cost.

High performance combined with the reliability and compactness of a printed circuit design are featured in the new Philbrick Universal Stabilized Amplifier, Model USA-3. It is ideally suited for applications to instrumentation, control and analog computation. Extremely high open-loop d-c gain, wide bandwidth, low noise and wide output range are important performance characteristics of this new chopper stabilized amplifier. An interesting design feature makes this instrument safe against self-destruction, even under prolonged overload conditions or direct grounding of its output. At a price of only $95.00, it offers more performance per dollar than any other amplifier on the market today. *Write to George A. Philbrick Researches, Inc., Dept. 12, for Bulletin USA-3.*

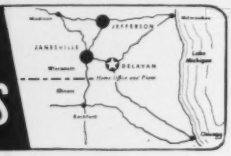
GEORGE A.
PHILBRICK
RESEARCHES, INC.
230 Congress Street, Boston 10, Massachusetts

For more information circle 73 on inquiry card.

WHO IS BORG?

Borg is a highly respected name in its field . . . the manufacture of components for systems. Borg has gained wide recognition as a supplier of electronic components for military and commercial uses.

BORG PLANTS



Borg manufacturing plants are centrally located about 90 miles from Chicago. Easily accessible by highway, rail and air.

WHAT BORG MAKES

Precision Is Our Business. For many years Borg has been prominent in the design and manufacture of precision components for systems.

- **AIRCRAFT INSTRUMENTS**
  Aircraft components, instruments and electronic sub-assemblies.
- **FREQUENCY STANDARDS**
  Crystal controlled oscillator type frequency standards.
- **POTENTIOMETERS**
  Quantity production of Borg MICROPOTS (precision potentiometers) to meet your specifications.
- **MICRODIALS**
  Precision MICRODIALS for single and multi-turn devices. Indexed accuracy of up to one part in 1,000.
- **INSTRUMENT MOTORS**
  Precision motors, synchronous and induction types. Gear trains.

BORG CAN HELP YOU

Borg can assist you in the design and construction of prototypes. Complete facilities for pilot runs and quantity production. Write for Bulletin BED-A50 or call us today.

BORG *Built by Borg*
MOTORS
MICROPOTS
MICRODIALS

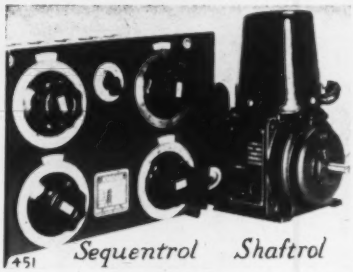
BORG EQUIPMENT DIVISION
THE GEORGE W. BORG CORPORATION
JANESVILLE, WISCONSIN

For more information circle **74** on inquiry card.

TIME, SEQUENCE, COUNT

PROGRAM CONTROLLER

New Sequentrol is for machine programming, work station control for assembling machines, etc. A vernier

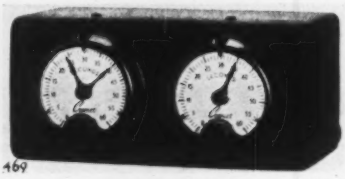


dial or revolution counter type control is set on its panel for each position or rate to be established. Each dial or counter commands a Shaftrol (shaft-mounted gear-motor designed to mount in place of handwheels). —*The Jordan Co., Inc.*, 3235 *W. Hampton Ave., Milwaukee* 9, *Wis.*

For more information circle **227** on inquiry card.

DUPLEX CYCLING TIMER

New Type 742 comprises two standard Type 412 motor-driven Automatic Reset Timers. After an initial



starting circuit is closed, each timer operates in turn providing a timed interval or delay, restarting the other at the conclusion of each timed period, and then resetting instantly (within ½ sec) ready for its next cycle. Standard ranges from 6 sec to 24 hr.—*Cramer Controls Corp., Centerbrook, Conn.*

For more information circle **228** on inquiry card.

TIME DELAY RELAY

New Model DED double-head Agastat time delay relay provides adjustable recycling by two-way action. Because of its two timing heads, a separate time delay can be set on each to allow an adjustable "on" and an adjustable "off" from 0.1 sec to 15 min.—*A'G'A Div., Elastic Stop Nut Corp. of America*, 1027 *Newark Ave., Elizabeth* 3, *N. J.*

For more information circle **229** on inquiry card.

INTERVAL TIMERS

Newly redesigned line of installed and plug-in single set interval timers comprises units manually pre-set for

number of minutes (or hours) required for each operation. Available time cycles of 24 hrs down to new 12-minute dial.—*Tork Time Controls, Inc., Mount Vernon, N. Y.*

For more information circle **230** on inquiry card.

TIMING MOTOR

New Inductor Timing Motor for heavy-duty operation is a permanent-magnet type with guaranteed torque

of 30 oz-in at 1 rpm and 60 cps. Available with output shaft speeds from 1 to 60 rpm, 120 and 240 v, 50 and 60 cps, clockwise or counter-clockwise.—*The Haydon Mfg. Co., Inc., Torrington, Connecticut.*

For more information circle **231** on inquiry card.

INTERNAL PINION COUNTERS

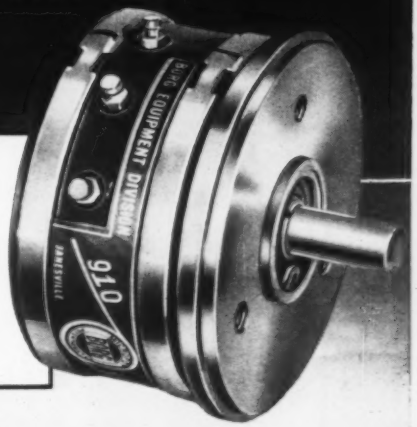
New internal-pinion-type counters can operate at speeds above 500 rpm; are available in 2-, 3- and 4-digit versions. Internal transfer pinion type of construction offers maximal numeral size (¼" high) in minimal space. Illustration shows decimal model; models offering five counts per revolution of input shaft are also available. Masks with fixed zeros are available.—*Bowmar Instrument Corp., Plant* 2, *Fort Wayne, Indiana.*

For more information circle **232** on inquiry card.

Shock after Shock

THROUGH THE SONIC BARRIER...

BORG MICROPOTS *Can take it!*



NEW!
BORG 910 SINGLE-TURN PRECISION MICROPOT

The new Borg 910 Series Single Turn Micropot retains its high precision characteristics through severe vibration and shock. Borg 910 Micropots were developed from the Borg 900 Series Micropots . . . long preferred in aircraft and electronic fields for accurate, long lived dependability. Let your nearest Borg "Tech-Rep" show you the many advantages offered by the new Borg 910 Series Single Turn Micropot.

WRITE FOR CATALOG SHEET BED A-69 AND NAME OF YOUR NEAREST BORG TECH-REP

BORG EQUIPMENT DIVISION
THE GEORGE W. BORG CORPORATION
JANESVILLE, WISCONSIN

ELECTRONIC – MECHANICAL BORG EQUIPMENT

Built by Borg

MOTORS
MICROPOTS
MICRODIALS

For more information circle **75** on inquiry card.

Pilot Malting Plant and Panel Board of the George J. Meyer Malt & Grain Corp., Buffalo, N.Y.

Important data for malting research recorded on TECHNICAL CHARTS!

This tower-like pilot malting plant is completely automatic, with more than 50 miniature valves, gates, dampers and similar devices. During research on the 10 day cycle of converting barley to malt, variables of temperature and moisture are accurately recorded at 42 points on TECHNICAL strip charts

Research scientists as well as production engineers the country over rely on the accuracy found in every TECHNICAL chart. They also appreciate TECHNICAL'S ability to supply charts for **all** their instruments, regardless of "make". If you are not already a user, join the thousands who are by specifying TECHNICAL.

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For more information circle **76** on inquiry card.

MOTION, STRAIN, etc.

DISPLACEMENT PICKUP

New 600-XS-AT Linear Variable Differential Transformer has ±0.6" linear range (1.2" total travel). De-

446

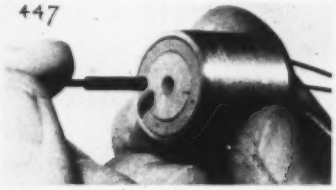
sign permits flexibility in alignment and variable distance between mounting points. Change in sensitivity over temperature range −65°F to 225°F is 1.5%. Output, at 10 v 400 cps input into a 0.5 meg load, 6.4 v at 0.600" displacement. Primary impedance 90 ohms; differential secondary 155 ohms. Complete assembly weighs 95 grams.—*Schaevitz Engineering, P. O. Box 505, Camden 1, N. J.*

For more information circle **233** on inquiry card.

DISPLACEMENT PICKUP

New Atcotran differential transformer meets specs for a null voltage of less than 2 millivolts; is friction-

447

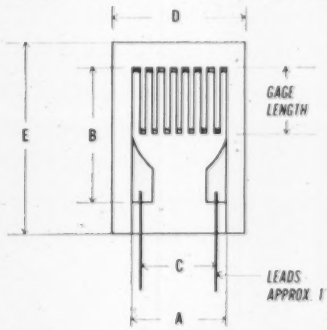


less; has unlimited life. Coil is ⅞" long and ⅞" OD, is designed for an armature range of ±0.02". Output, from two series-aiding secondaries to a transistorized amplifier, is linear within 0.1%.—*Automatic Timing & Controls, Inc., King of Prussia, Penna.*

For more information circle **234** on inquiry card.

FOIL TYPE STRAIN GAGES

Two new easily-applied foil types of SR-4 (bonded filament) strain gage provide fatigue life, sensitivity,



and hysteresis characteristics superior to those of nearest equivalent bonded-wire SR-4 strain gages. —*Electronics and Instrumentation Div., Baldwin-Lima-Hamilton Corp., Waltham, Mass.*

For more information circle **235** on inquiry card.

Coffee-break Reading—

IF you are responsible for (or are engaged in) the design, development, purchase or production of systems requiring precision timing, you realize the distinct advantage of knowing about the companies from which you buy. The background, experience, reputation of these suppliers and the application of their products can, as you know, act as a valuable guide in saving time and money, — not to say the avoidance of regret and disappointment.

● So, over your coffee cup, know ye that: —

● Our products consist basically of frequency standards and precision, electronic forks, (50 to 3000 cycles, accuracy to 1 part in 100,000 or better if required). These are available separately for integration with units of your own manufacture or as parts of instruments made by us.

● Several of our executives have engaged in the engineering of these frequency standards and precision forks for more than 20 years; a few more are at the 15-year mark. During this time we have learned much regarding the subtle idiosyncracies of materials and the mischievous capers of delicate processes. Each of our completed production units undergo 85 measurements. A single transistorized standard contains copper, steel, nylon, silicone rubber, glass, carbon, teflon wire, mylar capacitors, silicon diodes and a fork alloy containing 15 elements. So what? Accuracy, dependability, stability . . . superiority.

● In miniaturization, our staff has produced units which, in a 5-ounce, 6-cubic inch volume have proved more rugged and possess efficiency superior to 60-pound, 3-cubic foot units in general use some years ago.

● Our company has been in the frequency standard business for 20 years. Instruments of our manufacture have met the rigid inspection and exacting tests imposed by governments, the armed forces and industry for widely varied, high-precision timing applications. Continuing reorders and our consequent growth attest the satisfaction of our products.

REPRESENTATIVE FIELDS OF APPLICATION

Aviation, Navigation
Ordnance, Ballistics
High-speed Photography
Viscosity Measurement
Fluid Flow
Nuclear Physics
Telemetering
Chemical Reaction
Radiation Counting
Computers
Facsimile
Fire Control
Accurate Speed Control
School and Indl. Research Labs.

American Time Products, Inc.

580 Fifth Avenue, New York 36, N.Y.

OPERATIONAL INFORMATION SYSTEMS discussed by *Hank Bechard*

Fundamentally, Operational Information Systems are designed to provide immediately available digital information about selected physical phenomena affecting a process. Such information can be related to plant operating efficiency or used continuously to check product specifications. At present such process trend information is computed manually, and results are usually not available for several hours after corrective measures could have been instigated. The design goal is to obtain an information gathering system which will provide data on a real-time basis so that such corrections may be made immediately.

If properly designed, an Operational Information System can be made to provide better process information than is now being obtained by tailoring individual data-collecting systems for each specific function of a process. The versatility achieved with this approach is characterized by the fact that data-handling modifications of the Operational Information System are made possible without having to resort to redesign. Thus, adding to or expanding the System is readily accomplished within the limitations of the computing and memory capacities designed into it. The changes can also be made rapidly without the loss of any information pertaining to the physical phenomena being studied.

The design of a universal system of this type implies functional construction. Its distinctive feature is that it incorporates a specially designed digital computer as the fundamental building block. Analog to digital conversion as well as input scanners and output recording components are then added to it. And in contrast to special purpose computing elements, the Operational Information System features completely flexible internal programming.

In the conventional data-logging system, programming is accomplished by means of an input switching system where an additional contact for each input is needed in conjunction with a patchboard in order to introduce the specific instruction peculiar to the input. In the Operational Information System, pinboards or patchboards—accessories to sequence-scanning devices—are entirely eliminated. Programming is accomplished by punching paper tapes with all the necessary instructions and feeding this information into the computer where it is stored magnetically. The instructions can therefore be varied at any time without making any physical changes to the equipment. A single memory unit is incorporated for all memory requirements such as: scanning sequence, sampling schedules, linearizations, scaling factors, range suppressions, alarm levels, alarm conditions, temperature and pressure values for flow adjustment, computation instructions, etc. Since this memory unit is designed to permit random access, the greatest freedom is available to schedule sampling rates and sequences. For instance, the repetitive scanning of a selected input may be intermingled with single sequential scanning of other inputs.

Henry L. Bechard, administrative engineer, describes Operational Information Systems.

In the Operational Information System all analog voltages are converted to the digital form before any operations whatever are performed upon them. By digitizing the voltages immediately, and not operating upon them in the analog form, inaccuracies introduced by analog computations are completely avoided. This is particularly important in the more intricate computing operations, and guarantees digital accuracy for all operations.

Progressive industrial management has invested in conventional data-logging systems primarily in the interest of gaining experience in this area. Time and again such experience has yielded significant process information leading to improved plant performance and more economical operation, and in scattered cases has even led to minor loop control.

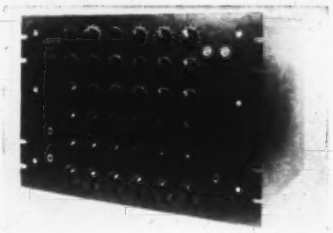
The concept of the Operational Information System capitalizes upon this accumulation of experience gained in data-handling and process control and now, in a single versatile system, takes the boldest step yet forward toward filling industry's ultimate goal of "closing the overall process loop."

By applying the latest proven techniques, our well-qualified staff at Daystrom Systems is prepared to take single responsibility of assembling and installing a system to meet your needs. We are currently compiling a file of new applications and papers on various parts of systems, both industrial and military. If you are interested in receiving the file and periodic additions, please write us.

DAYSTROM SYSTEMS
Division of Daystrom, Inc., 5640 La Jolla Boulevard
La Jolla, California Telephone GLencourt 4-0421

"FUNCTION OF 2 VARIABLES" COMPUTING COMPONENTS

New Model F2V Function of Two Variables provides an output voltage which is an arbitrary function of two

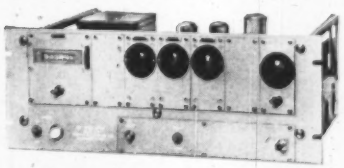


independent varying input voltages. A family of curves is produced with smooth interpolation in both directions. This surface may be visualized as a tent with 36 poles where the height of each pole is individually adjustable between plus and minus 50 v.—*George A. Philbrick Researches, Inc., 230 Congress St., Boston 10, Mass.*

For more information circle **236** on inquiry card.

HIGH-SPEED SCALER

New Model 379 High Speed Scaler features rates up to 50,000 pulse counts per second with pulse pair re-

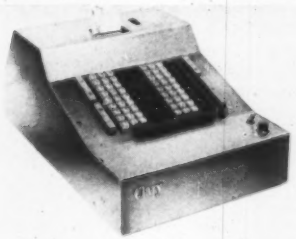


solution time of less than 1 microsecond; scale of 10 using a type 6700 Beam Switch Tube, 3 cold-cathode decade counters and 6-digit electromechanical register.—*Franklin Electronics Inc., Dept. 325, E. 4th St., Bridgeport, Pa.*

For more information circle **237** on inquiry card.

SCANNING PRINTER

New 1960 scanning printer is a self-contained unit capable of converting a parallel set of decimal con-

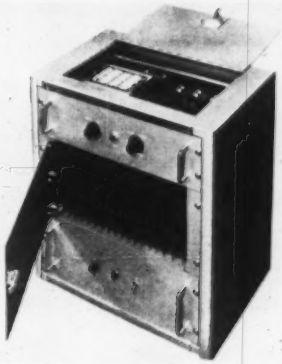


tact closures into a printed digatal record. Maximum number of leads between printer and device being read is 25; maximum printing capacity is 12 digits per line with minimum printing rate of 3 lines per second.—*Clary Corp., San Gabriel, Calif.*

For more information circle **238** on inquiry card.

BUFFER STORAGE UNIT

New Type 1092-BQ-8 completely-transistorized coincident-current magnetic core buffer storage unit can



be used as a temporary store, buffer or delay unit in data processing, computing and automation systems. Each of its 1,092 characters has a capacity of 8 binary digits in length.—*Telemeter Magnetics, Inc., 2245 Pontius Ave., Los Angeles 64, Calif.*

For more information circle **239** on inquiry card.

DATA SELECTOR FEATURES

Two new optional features increase capacity and flexibility of 774 Tape Data Selector: (1) File search feature enables users to rapidly locate individual record or class of records within a file of magnetic tapes, at speed of 15,000 characters/sec; (2) Additional magnetic core storage enables users to avail themselves of 120, 140, or 160 positions of storage, depending on model selected. This additional capacity makes possible punching and comparing 80 columns of data with the 519 Document Originating Machine.—*International Business Machines Corp., 590 Madison Ave., New York 22, N. Y.*

For more information circle **240** on inquiry card.

MAG-TAPE BULK ERASER

New Model HD-11 Magnetic Tape Bulk Eraser erases recorded signals and noise from magnetic tape below

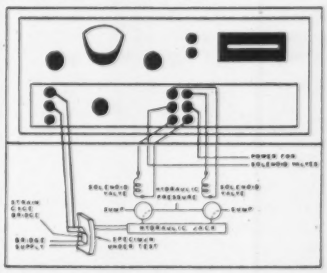
385

level of standard erase heads. Spindle mounting of reel permits rapid, thorough coverage without missed spots.—*Microtran Co., Inc., 145 E. Mineola Ave., Valley Stream, N. Y.*

For more information circle **241** on inquiry card.

FOR
Automatic Control
OF TEST LIMITS
USE THE
SPAR PROGRAMMER COUNTER

The SPAR Programmer Counter is a precision unit that eliminates manual control of test cycling and simplifies the setting up of equipment each time a test is to be made.



The SPAR Programmer Counter is a compact, precision-made device that automatically turns on and off test apparatus whose limits are sensed by strain gages, thermocouples or any other transducers that have a maximum output not exceeding 100 millivolts DC. It simplifies the setting up of equipment each time a test is to be made and eliminates the need for manual control of test cycling. A counter, which may be of the preset type, registers each cycle.

- The unit, which operates on 110V AC, is a stable, precision, millivolt electronic relay having adjustable energizing and release thresholds and DPDT 15 amp contacts.
- Two, adjustable, stable thresholds provide for precise selection of upper and lower operating limits.
- Models can be obtained with up to 5 sets of adjustable limits with automatic switching by preset counters.

SPAR Bridge Power Supply Unit...

This unit for supplying power to bridges and strain gages is regulated and filtered by transistors. It has an extremely low ripple. Output is 0 to 25 DC up to 400 milliamperes.

Write, wire or call for full details on this SPAR equipment

Spar **ENGINEERING and DEVELOPMENT** INCORPORATED

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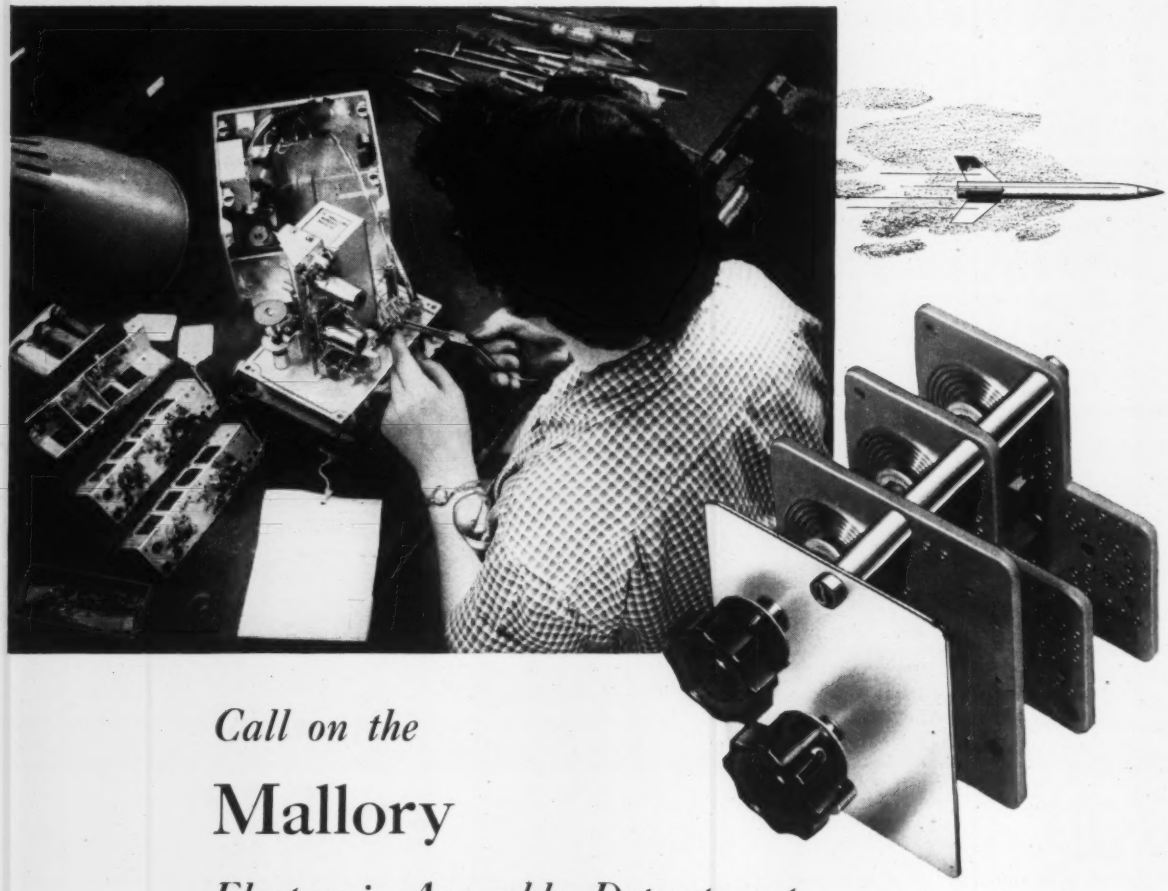
For more information circle **79** on inquiry card.



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For more information circle **80** on inquiry card.

DIMENSIONAL GAGING and INSPECTION

PNEUMATIC COMPARATOR

New model L air Gage combines high speed with direct readings to user's choice of least division (0.00005", 0.0001" or 0.0002") and repeatability within this reading. Among other features: steel chrome-plated and tungsten carbide gaging elements; max-and-min master calibration: accurate air-pressure control.—*Freeland Gauge Co., 9940 Freeland Ave., Detroit 27, Mich.*

For more information circle **242** on inquiry card.

ELECTRIC COMPARATORS

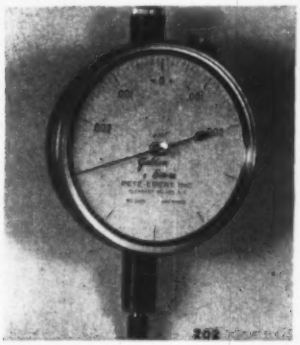
New signal light attachment reports accurately within 20 millionths of an inch over- and under-size as

well as correct size by flashing of green, red or yellow light.—*George Scherr Co., Inc., 200 Lafayette St., New York 12, N. Y.*

For more information circle **243** on inquiry card.

DIAL INDICATORS

New "Golden Em-re" series dial indicators provide accuracy of ½ graduation over entire range; are well

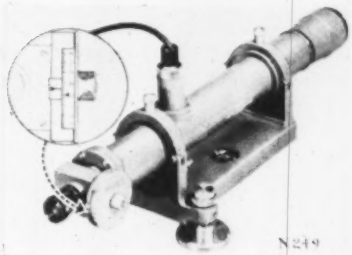


suited to either production line or laboratory use.—*Petz-Emery Inc., Pleasant Valley, N. Y.*

For more information circle **244** on inquiry card.

AUTO-COLLIMATOR

New improved model of "Watts Microptic Auto-Collimator" has a new micrometer drum arrangement that

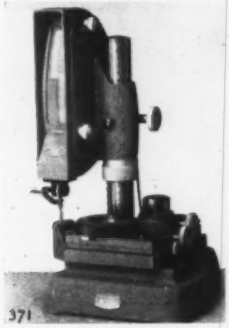


permits direct reading to 0.1 second of arc.—*Engis Equipment Co., 431 S. Dearborn St., Chicago 5, Ill.*

For more information circle **245** on inquiry card.

I. D. COMPARATOR GAGE

New Leitz Internal Tolerator Gage obtains a true I.D. measurement by straight-line 2-point contact method.

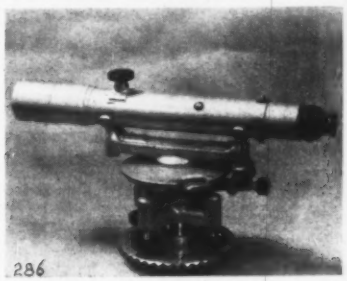


For determining straightness of bore, taper or bell-mouth, table can be moved vertically by rack and pinion.—*Opto-Metric Tools, Inc., 137 Varick St., New York 13, N. Y.*

For more information circle **246** on inquiry card.

LIGHT DUMPY LEVEL

New Light Dumpy Level model, Number 380, is without horizontal circle. Model Number 380-A has a



circle for reading horizontal angles to five minutes. Telescope is short (13"); features brilliant illumination; hard-coated lenses; minimum focus 6½ ft.—*W. & L. E. Gurley, Troy, N. Y.*

For more information circle **247** on inquiry card.

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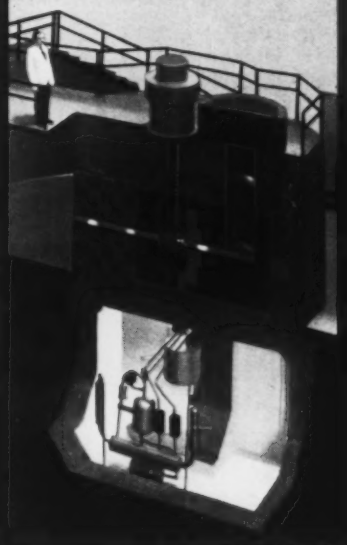

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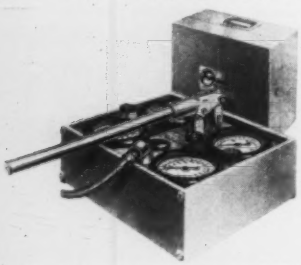
For more information circle **81** on inquiry card.

MECHANICAL TESTING

HYDROSTATIC TESTER

New "utility" version of Porta-Tester, weighing only 55 lb and contained within a carrying case, is for



general industrial use in at-the-site hydrostatic testing of valves, pressure vessels, piping, steam generators, pump cases and other process equipment, to 3000 psi.—*Farris Engineering Corp., 705 Commercial Ave., Palisades Park, N. J.*

For more information circle **248** on inquiry card.

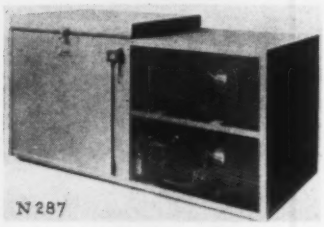
POLYETHYLENE TESTER

New method compares heat resistant qualities of polyethylene samples and indicates approximate maximum temperatures which a sample will withstand under no-load or minimum stress conditions. Test is performed by an "Aminco Vicat Softening Point Kit" used in conjunction with an "Aminco Heat Distortion Tester," determines temperature at which an arbitrary needle penetration occurs when specimens are subjected to arbitrary test conditions.—*American Instrument Co., Inc., Silver Spring, Md.*

For more information circle **249** on inquiry card.

LOW-TEMPERATURE CABINET

New 8 cu ft "Model WE-8-125 Industrial Freezer," designed for testing electronic components, stabilization of



metals, and thermal contraction and expansion fitting, features rapid pull-down: from ambient to −100°F in 30 min; temperature range from ambient to −125°F. Inside dimensions 24" x 24" x 24; four 10" x 10" x 10" cadmium-plated baskets.—*Webber Engineering Corp., P. O. Box 217, Indianapolis 6, Ind.*

For more information circle **250** on inquiry card.

INDENTATION TESTER

New production-model of McBurney Indentation Tester for testing asphalt tile meets Federal Spec SS-T-306b; comprises a rod with a hemispherical end 0.25" diam, through which required loads up to 30 lb can be applied to tiled surface. Indentation is indicated to closest 0.001". Aminco Constant Temperature Bath is recommended for use with McBurney Indentation Tester.—*American Instrument Co., 8030 Georgia Ave., Silver Spring, Maryland.*

For more information circle **251** on inquiry card.

POWER SUPPLY UNIT FOR STRAIN GAGE BRIDGE

New transistor-filtered and regulated unit, primarily for use as a power supply for a 120-ohm strain

gage bridge, contains a wired bridge with front-panel facilities for using from one to four strain gages as either active or dummy elements; provides initial balancing facilities with both coarse and fine adjustments.—*Spar Engineering & Development, Inc., Paxson and South Aves., Wyncote, Pa.*

For more information circle **252** on inquiry card.

panel mounted Pyrometers with Alnor® Accuracy

Alnor Pyrometers are designed to give consistently accurate temperature readings under the most severe conditions of vibration, dirt and corrosive atmosphere. Sturdy, laboratory-precise movements are cushioned in fume-proof, splash-proof welded steel cases in front of board or flush type mountings. Six series available for single circuit up to 31 circuit applications. Eleven standard ranges covering 0-300° F. to 0-3000° F. or centigrade equivalents.

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Multi-circuit series data covered in Bulletin 4361.

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For more information circle **83** on inquiry card.

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®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

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Original performance constant over a long pump life.
Low maintenance cost.

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ELECTRICAL TESTING

TV AND RADIO TESTER

New Model 828 Intermittent Condition Analyzer uses a new principle which makes TV or radio receivers supersensitive to intermittent and pre-intermittent noises caused by components. Sensitive amplifier and intermittent tracer probe pick up and localize noises produced by borderline components without waiting for actual breakdown to occur.—*Winston Electronics, Inc.*, 4312 *Main Street, Philadelphia* 27, *Pennsylvania.*

For more information circle **253** on inquiry card.

S-BAND CAVITY OSCILLATOR

New "500 Series" miniaturized grid-separated double-coaxial-line cavity oscillator for either pulse or cw operation utilizes GL-6442 tube; is especially suitable for aircraft, guided missile and beacon applications, owing to its lightweight (25 oz with tube), mechanical strength, and high operating efficiency under severe shock and vibration conditions. Tuning range as a pulse cavity oscillator over 200 Mc in S-band region with peak power output of 1 kw in upper range and 2 kw in lower range, with duty cycle of 0.001. Plate voltage 2000 at 4 amp. Over-all length 7". Weight 25 oz. with tube.—*Amerac, Inc.*, 116 *Topsfield Road, Wenham, Mass.*

For more information circle **254** on inquiry card.

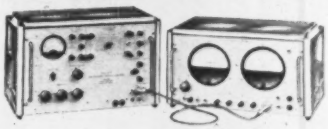
MICROWAVE SPECTRUM ANALYZER

New Model SA30 for table top or rack mounting, and using interchangeable RF tuning assemblies, features a new Model 30X5 Direct-Frequency Reading X-Band (8500-9660 Mc) RF head, having 0.5% accuracy, and other precision heads from 800 to 40,000 Mc.—*Vectron, Inc., Waltham* 54, *Mass.*

For more information circle **255** on inquiry card.

SYSTEM ANALYZER

New Transfer Function Analyzer is said to be "the most advanced instrument in the world designed to



test servomechanisms under conditions where the servo output may be non-linear." It provides all necessary information on two dials for plotting phase and gain diagrams "which it does more accurately than any other instrument." Frequency range 0.5 cps to 1 kc. Among other uses: low-frequency wave analysis, network and filter analysis, testing controls and amplifiers, etc.—*Solartron*, 10761 *Burbank Blvd., North Hollwood, Calif.*

For more information circle **256** on inquiry card.

RELAY TEST SET

New Model 4501 Relay Test Set permits five separate testing and adjustment measurements to be made

on high-speed polar relays used in pulse equipment such as computers and teletypewriters. Among features: regulated dc power supply; all controls, indicators and terminals on front panel; limitation of exposed voltage to safe values; accessible construction for easy servicing.—*Sigma Instruments, Inc.*, 47 *Pearl St., So. Braintree* 85, *Mass.*

For more information circle **257** on inquiry card.

INSULATION TESTER SWITCH

New A-R-K 4-position switch on Meg type of Megger insulation tester makes these hand-operated generator models provide facilities not formerly available in one instrument. A-R-K switch includes: (A) megohms $\div \times 1$ and $\div \times 10$, (R) ohm scale (K) capacitance discharge switch. In addition Earth, Line and Guard terminals are so arranged as to require no change of connections when switching to ohm scale.—*James G. Biddle Co.*, 1316 *Arch St., Phila.* 7, *Pa.*

For more information circle **258** on inquiry card.

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For more information circle **84** on inquiry card.

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−30° to +120°F	7 Days
−30° to +120°F	24 Hours
−20° to + 40°F	24 Hours
−10° to + 50°F	7 Days
−10° to + 50°F	24 Hours
30° to 60°F	24 Hours
40° to 100°F	7 Days
40° to 100°F	24 Hours
60° to 90°F	24 Hours
60° to 90°F	8 Hours
70° to 130°F	24 Hours
−25° to + 10°C	24 Hours
5° to 40°C	24 Hours

Use TEMPSCRIBE Recorders

The TEMPSCRIBE self-registering Recording Thermometer meets a long-felt need for a moderately priced recorder for general purpose applications where a graphic record of temperature in surrounding air is required. The record—written on an easy-to-read chart, 4" in diameter, with graduations spaced uniformly over full range—is indispensable wherever knowledge is desired if temperature goes above or below any given point. TEMPSCRIBE is the only recorder made with pen and actuating element in door, which, when opened, permits a clear view of the complete chart, and easy chart replacement without danger of damaging pen arm or accidentally marking chart.

Write for Bulletin 704

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For more information circle **85** on inquiry card.

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will control it *AUTOMATICALLY* to an accuracy of .25%.

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For more information circle **86** on inquiry card.

ELECTRICAL INSTRUMENTS

WHEATSTONE BRIDGE

New 4735 Guarded Wheatstone Bridge has a range of 0.01 ohm to 1,111 megohms with a limit of error of 0.05% + 0.001 ohm up to 100 megohms and 0.5% above 100 megohms; is applicable to calibration of resistors on a production line basis, performing lab experiments and making routine resistance measurements.—*Leeds & Northrup Co.*, 4934 *Stenton Ave., Phila.* 44, *Pa.*

For more information circle **259** on inquiry card.

VACUUM-TUBE VOLTMETER

New lab-type vacuum-tube voltmeter features independent zero adjustments for ac, dc, and resistance

379

measurements to insure accurate readings. Nine dc ranges, 8 ac ranges, 9 resistance ranges.—*Acton Labs., Inc.*, 533 *Main St., Acton, Mass.*

For more information circle **260** on inquiry card.

MICROVOLTMETER & AMPLIFIER

New Model 202B is a combination dc microvoltmeter and amplifier. Chopper circuitry provides high sensi-

tivity with "previously unobtainable drift-free stability and high input impedance." Accuracy on all 14 ranges is 3% of full scale; output as amplifier is 1 volt across 1000 ohms or more full scale.—*Kin Tel*, 5725 *Kearny Villa Rd., San Diego* 11, *Calif.*

For more information circle **261** on inquiry card.

ILLUMINATED INSTRUMENTS

New models of black plastic 4½" rectangular Contact Meter-Relays, panel meters and pyrometers are

available with 6-v illumination. Two 3-v-0.19-amp aviation lamps, connected in series, are screwed into cases from front.—*Assembly Products, Inc., Chesterland, Ohio.*

For more information circle **262** on inquiry card.

AC ELECTRONIC VOLTMETER

New Type 10A battery-operated ac electronic voltmeter features space-saving all-transistor design and

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For more information circle **171** on inquiry card.

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For more information circle **87** on inquiry card.

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- Wide range: 0 to 141.1110 ohms in increments of 0.0001 ohm
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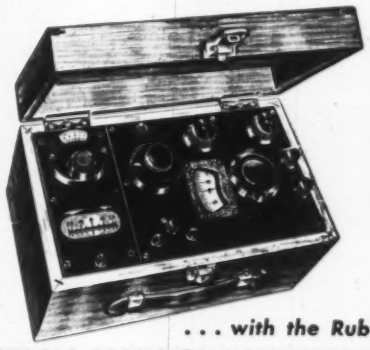
- Built-in mercury commutator for lead resistance compensation
- Sub-panel switch construction
- Built-in plug and block assembly for conveniently checking ratio, bridge zero and thermometer resistance with no disturbance of external bridge connections

Described in Bulletin 100



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- High-sensitivity, sturdy, built-in Pointerlite galvanometer —permits balancing to within 2 microvolts in low resistance circuits
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- Two ranges —0 to 16.1 and 0 to 161 millivolts—readable to within 2 and 20 microvolts respectively
- Sturdy, compact construction for long dependable service

Described in Bulletin 270

RUBICON COMPANY
Electrical Instrument Makers

3755 Ridge Avenue Philadelphia 32, Pa.

For more information circle **88** on inquiry card.

"One o'clock... and all's well"

Special 60-channel Bristol charts (above) automatically register this modern-day night watchman's cry at the Scovill Manufacturing Co., Waterbury, Conn., fabricators of brass mill products and manufacturers of a wide variety of items for industrial and consumer use. The time each watchman "rings in" is indicated on the charts and any delays signal the plant protection force for appropriate action.

The special chart for this unusual application is one of hundreds Bristol has made to order for scientists, engineers and instrument designers. Our recently expanded chart printing facilities can handle strip charts up to 29¾ inches across; circular charts to 12 inches diameter. And, naturally, special charts that we print get the benefit of our 68 years of experience in chart printing for our own Bristol instruments.

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BRISTOL *TRAIL-BLAZERS IN PROCESS AUTOMATION*

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For more information circle **89** on inquiry card.

Using vertical polarized light on a cross-section of pipe, photographer Bernard Hoffman clearly shows the ravages of corrosive action.

Controlling Corrosion in Fluid Engineering

Corrosion seldom works alone. Together with heat, pressure and abrasion factors, it compounds the problems of fluid engineering. But when you have valve design problems involving corrosion, you can look to the engineering leadership available at S. Morgan Smith for assistance.

You can use R-S Rubber-lined Butterfly Valves, for instance, to handle many special applications. The rubber lining protects the entire valve body, gives you corrosion resistance with maximum economy. Where your processing problem demands additional engineering, you can draw on the broad SMS background of experience in specialized valve applications.

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For more information circle **90** on inquiry card.

printed wiring; is said to bring lab precision to field applications. Ranges from 1 mv full-scale to 300 v full-scale within frequency range of 20 cps to 500 kc.—*Alectra Div., Consolidated Electrodynamics Corp., 325 N. Altadena Dr., Pasadena, Calif.*

For more information circle **263** on inquiry card.

STANDARDIZATION CONSOLE

New console for calibrating ac and dc current and voltage instruments provides power source, control, and

circuitry for high-accuracy instrument standardization from microvolts and microamperes to several hundreds volts or amperes—a measurement range of nearly 10^9. With all necessary operating equipment it measures 6 ft long, 4 ft wide, and 5 ft high. Design simplicity permits rapid, easy calibration by non-skilled workers; safety features make it virtually impossible to damage instruments on test or console itself.—*General Electric Co., Schenectady 5, N. Y.*

For more information circle **264** on inquiry card.

OSCILLOGRAPH

New Model S-25C, for R&D projects with exceptional recording demands, is an advanced model of

maker's S-25 oscillograph. New feature is quick cartridge loading of record magazine. 12"-wide recording paper can record 18 channels with OA-2 and OA-3 galvanometers and up to 48 channels with OV galvanometers. Among exclusive features: automatic replacement of lamps upon burnout, instantaneous pushbutton chart speed selection while operating, automatic trace density control, con-

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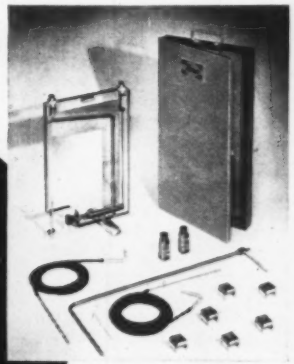
AIR VELOCITY METER No. 400

One Instrument Tells Both Air Velocity and Static Pressure!



- Reads directly in feet per minute and inches of water.
- Check *all* velocities from 400 to 10,000 F.P.M.
- All static pressures from 0 to 10" of water.

Tests fan and blower discharge and inlet pressures, pressure drop across filters, balances air conditioning systems, etc. Complete kit includes dual purpose manometer, 18" stainless steel pitot tube, Magneclips and all necessary fittings, tubings, instructions and accessories.

Write today for literature and prices.

F. W. DWYER MFG. CO.

P.O. BOX 373-S MICHIGAN CITY, INDIANA

For more information circle **92** on inquiry card.

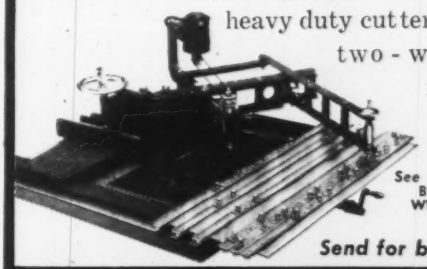
Now—

NO plate too small— 2138

NO panel too big

NO size limits on engraving

The new ENGRAVOGRAPH Model I-R takes up only 2 feet of bench space and engraves anything from tiny nameplates to giant panels. Engraving chassis can be detached from base and placed directly on workpiece of any dimension. Smaller plates can be easily clamped in a self-centering workholder which is standard equipment. New sturdy pantograph construction; heavy duty cutter spindle; two-way depth regulator.



See demonstration at BOOTH #2904 WESCON SHOW

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13-19 UNIVERSITY PLACE, NEW YORK 3, N. Y.

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Full 3½" Dial Face

- No Sector
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THERMOMETERS, INC.

Norwood Ave., Cincinnati 12, Ohio

Mfrs. of Industrial Laboratory Recording and Dial Thermometers

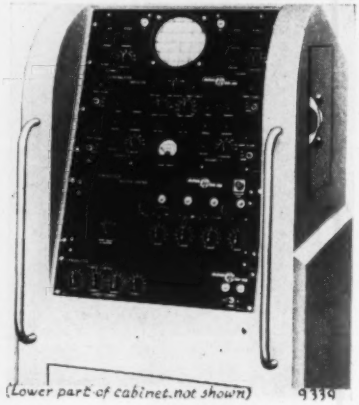
For more information circle **93** on inquiry card.

tinuous monitoring of reserve chart supply, automatic record numbering, automatic record length control, and automatic selection of time line intervals.—*Hathaway Instrument Div., Hamilton Watch Co., 5800 East Jewell Ave., Denver 22, Colo.*

For more information circle **265** on inquiry card.

FOUR-CHANNEL 'SCOPE

New Model H-42B Master Strainalyzer is sensitive 4-channel recording oscilloscope which triggers events and



records resulting operational phenomena. Four-gun (4-beam) tube for recording on moving film, any desired period from 100 μsec interval (single sweep) to hours.—*Electronic Tube Co., 1200 E. Mermaid Lane, Philadelphia 7, Pa.*

For more information circle **266** on inquiry card.

OSCILLOGRAPH

New CR-1B Recording Oscillograph can record simultaneously up to 16 channels of phenomena at frequen-

cies as high as 100,000 cps on a single 8"-wide record.—*Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.*

For more information circle **267** on inquiry card.

ELECTRICAL-INSTRUMENT ACCESSORIES

CATHODE-RAY TUBE

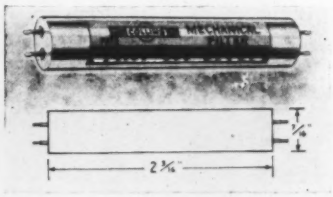
New Type 3AHP RAYONIC high-performance rectangular 3" tube was designed to give maximum emphasis

to brightness and definition. Vertical sensitivity of 26 to 35 vdc per inch is achieved with a second anode voltage of 1000; 2000 v at second anode gives sensitivity of 52 to 70 v/in. Choice of P1, P2, P7 and P11 phosphors.—*Waterman Products Co., Inc., 2445 Emerald St., Phila. 25, Pa.*

For more information circle **268** on inquiry card.

MINIATURE FILTERS

New Y Series miniaturized mechanical filter, hermetically sealed in a metal tube 2-$\frac{3}{16}$" L by $\frac{7}{16}$" D, represents a substantial size reduction



is said to be ideal for printed circuits. Models are available in center frequencies of 455 kc with 6 db, bandwidths of 2.1, 3.1, 4.0, 6.0, 8.0, 12.0, 16.0, and 35.0 kc.—*Communication Accessories Co., Lee's Summit, Mo.*

For more information circle **269** on inquiry card.

ELIMINATOR FILTER

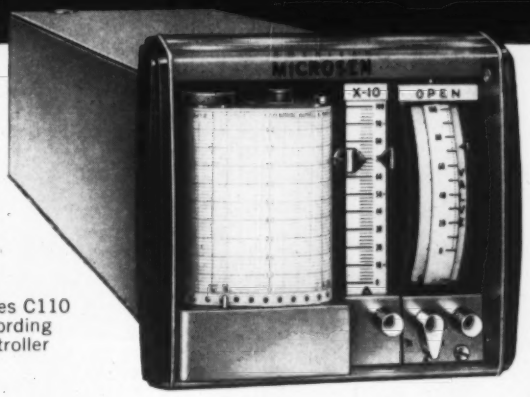
New Model 1055 Battery Eliminator Accessory provides additional filtering of the output of 6-v and 12-v battery eliminator and charger or similar unit when used for powering transistorized equipment; is an *L-C* type filter; is adequately rated to remain in use for all functions of eliminator.—*Electronic Instrument Co., Inc., 84 Withers Street, Brooklyn 11, New York.*

For more information circle **270** on inquiry card.

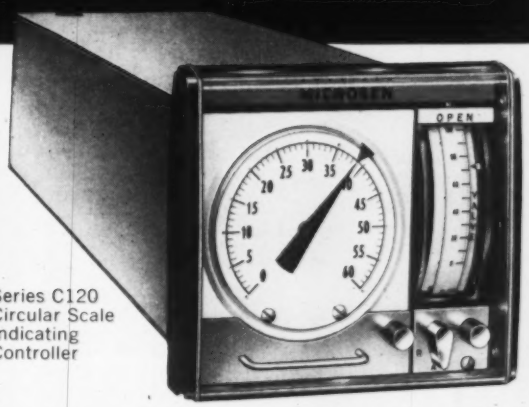
INSTRUMENT AMPLIFIER

New Model 2616 Amplifier, designed for impedance matching of piezoelectric pickups or other high-impedance signal sources to direct driving of galvanometers or indicators, features 3 channels with in-

NEW TRANSISTORIZED ELECTRONIC CONTROLLERS Interchangeable for complete versatility



Series C110
Recording
Controller



Series C120
Circular Scale
Indicating
Controller

The new 'American-Microsen' Series C100 Electronic Controllers can be interchanged at the panelboard in seconds. A recording controller to an indicating type . . . a proportional-action controller to proportional-plus-reset . . . slow reset to fast reset – any of these replacements is quickly made by pulling one unit out and plugging in the other.

The controller settings of the 'American-Microsen' System are all calibrated and repeatable. When a controller station is replaced, the proportional, reset and rate settings can be made in advance so the process is on control the instant the changeover is completed. No playing around to tune in the control.

When the process is on manual control during a replacement operation, the controller station stays in balance with the actual valve position. Thus the process can be changed back to automatic control without "bumping" or upset. A unique feature of the 'American-Microsen' System eliminates any "balance" or "seal" position between manual and automatic.

These are but a few of the many functional advantages of the new 'American-Microsen' Electronic Control System. Join the many satisfied users of this new approach to process control. Make certain you have the better control and simplified servicing so essential to higher product quality and greater operating economy. Arrange for a meeting with one of our sales engineers to determine the best equipment for your service. *Write for Bulletin RC100.*

Controller Performs These Functions

Measures input signal from transmitter and records or indicates in terms of the measured variable — pressure, temperature, flow, etc. (The Series C110 records on a 3-inch wide strip chart, the Series C120 indicates on a 4-inch diameter scale.)

Provides means of setting the desired value of the measured variable (set point) and compares actual value with desired value.

Transmits control signal, incorporating proportional, reset, and/or rate actions to operate final control element.

Provides means to operate control element manually with simple switch and manual knob.

Ultra-Modern Features Provided

All functions of recording (or indication), controlling (proportional, reset, and/or rate), and manual valve operation *in a single housing.*

Transistorized controller station for ultimate reliability and long service life.

Printed circuitry and miniaturized components for space-saving simplicity.

Plug-in units for complete interchangeability and ease of maintenance.

Ratio, cascade, and other similar control arrangements, using standard instruments.

Direct bumpless transfer from manual to automatic control with no intermediate position.

DC signals of 1.0 to 5.0 milliamperes for instantaneous distance transmission up to 30 miles.

Controllers are compatible with any unit of other manufacture using the standard 1 to 5 milliampere DC signal.

MANNING, MAXWELL & MOORE, INC.

MANNING MAXWELL & MOORE INC. TRADE MARK

INDUSTRIAL CONTROLS DIVISION • STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN-MICROSEN' ELECTRONIC INSTRUMENTS FOR MEASUREMENT, TRANSMISSION AND CONTROL

For more information circle **94** on inquiry card.

Gaertner Toolmakers' Microscope used to measure typical piece part. Co-ordinate range 4" x 2".

Precise measurement to 0.0001" and 1 min. of arc

Gaertner Toolmakers' Microscope

Here is a reliable, easy-to-use microscope for precise measurement of piece parts, tools, dies, thread gages, templates, jigs, fixtures, etc. Ideally suited for making a wide variety of precision measurements and is especially valuable in reducing rejects in production work.

With the Gaertner Toolmakers' Microscope you make direct, non-destructive measurements — no contact, no distortion, images are sharp and clear. It is a basic measuring instrument for inspection depts., gage labs, tool and die and model shops, industrial and research labs.

The Gaertner Toolmakers' Microscope has been proven in use by U. S. Government Gage Laboratories, and by prime contractors and their subcontractors. With all parties using the same measuring instrument, inspection procedures are co-ordinated and disagreements and rejects minimized.

Features that help you get
HIGH SETTING AND REPEATING ACCURACY

- Low, compact built-in rotary stage reads to 1 minute of arc throughout 360° range.
- Minimum overhang of stages.
- Full 2" precision-lapped lead screws with correction device.
- Straightforward, direct, uncomplicated optical system.

Features that assure you of
EASY, CONVENIENT OPERATION

- Independently rotatable cross hairs in protractor ocular speed up measurements, simplify measuring procedure.
- Convenient location of ocular eyepieces for ease of reading.
- Built-in transformer and plugs for all illuminators.

Modifications and accessories to
MEET YOUR EXACT REQUIREMENTS

- Thread and radius templates, camera and spotting attachments, fine motion focus, variable magnification available.
- If you have a special measuring problem, our staff of representatives will be happy to consult with you. The service and engineering facilities of the manufacturer are always immediately available to help you.

Write for Bulletin 147-56

Designed and manufactured by

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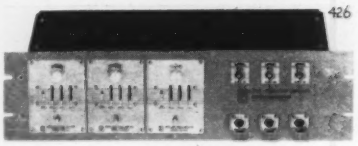
Telephone: BUckingham 1-5335

For more information circle **95** on inquiry card.

NEW INSTRUMENTS

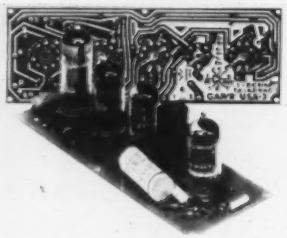


dividual gains of 1, 3, or 10. Three-decade shunt capacitor in each channel for standardizing each pickup to exact sensitivity desired. Addition of capacitance in steps of 10 to 10,000 mmfd is also used. Extremely low noise levels; gain linearity 1%; frequency response ±1.5% 2 cps to 15 kc.—*Endevco Corp.*, 161 *E. California St., Pasadena, Calif.*

For more information circle **271** on inquiry card.

STABILIZED AMPLIFIER

New Model USA-3 printed circuit Universal Stabilized Amplifier, for measurement, control, and analog

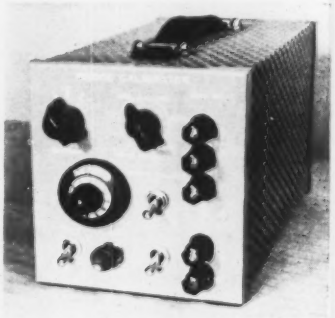


computation, is a chopper-stabilized unit with open-loop dc gain of 10 million, output range of ±115 v. When used at a gain of 100, accuracy is maintained well beyond 1 kc.—*George A. Philbrick Researches, Inc.*, 230 *Congress St., Boston* 10, *Mass.*

For more information circle **272** on inquiry card.

DC BRIDGE & CALIBRATOR

New BC-1, a companion component for any amplifier, provides: (1) an input circuit for conveniently con-

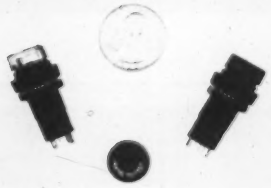


necting 1, 2 or 4 active wire strain arms into Wheatstone Bridge form; (2) means for bridge balancing, automatic 4-step signal calibration, and event of phenomenon initiation; (3) terminals for external bridge power. —*Allegany Instrument Co., Inc.*, 1091 *Wills Mt., Cumberland, Md.*

For more information circle **273** on inquiry card.

VAPOR-PROOF WATER-TIGHT INDICATOR

New miniature ungrounded indicator uses a T-1-¾ incandescent lamp for 28 v or an NE2 neon lamp for

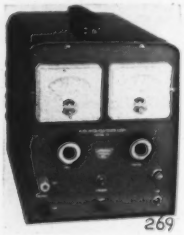


110 v operation. Lug area of base is potted and covered with a plastic boot. Mounting is by means of a $\frac{15}{32}$" hole and up to $\frac{1}{8}$" mounting panel.—*Marco Industries Co.*, 207 *S. Helena St., Anaheim, Calif.*

For more information circle **274** on inquiry card.

POWER SUPPLIES

DC POWER SUPPLY

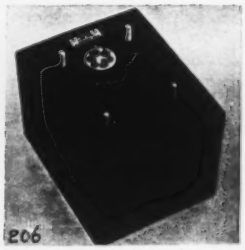


New ultra-regulated low-voltage dc power supply utilizes an ultrasonic carrier system to achieve optimal performance consistent with light weight, compactness, and efficiency. Can produce 0 to 7.0 v at up to 1.5 amp. Regulation is complete even down to 0 v.—*Optimized Devices, Inc., Box* 38, *Gedney Station, White Plains, New York.*

For more information circle **275** on inquiry card.

AIRCRAFT POWER SUPPLIES

New strain gage power supplies, for operating strain gages and telemetering equipment in aircraft sys-



tems, feature tubeless construction. Model No. 562 provides a dc output of 5 volts @ 1 amp; ac input of 105-125 volts, single phase; 380-420 cycles.—*Perkin Engineering Corp.*, 345 *Kansas St., El Segundo, Calif.*

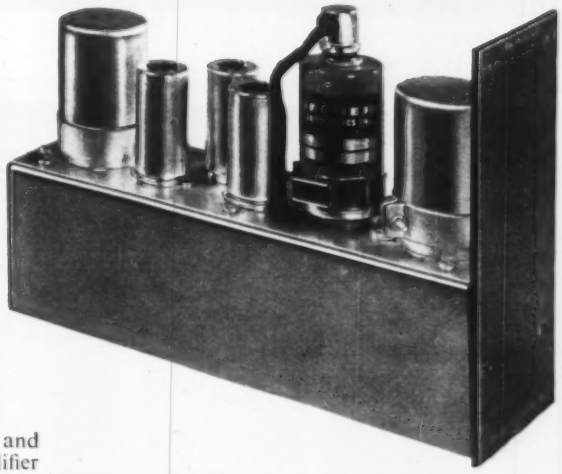
For more information circle **276** on inquiry card.

INSTRUMENT POWER SUPPLY

New Model 170 Electronic Battery is designed to replace storage battery and floater combinations for spectro-

THE OFFNER TYPE 190

differential DATA AMPLIFIER



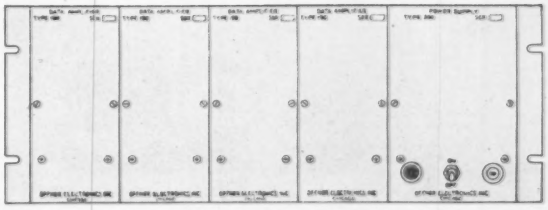
d-c Amplifier with zero drift and 1/100th percent gain stability

For amplification of thermocouple, strain gage, and similar low level signals the Type 190 Data Amplifier provides a combination of features available in no other amplifier:

- ☆ **Infinite rejection of common-mode d-c signals**
- ☆ **One microvolt input resolution**
- ☆ **Gain stability of 0.01%**
- ☆ **Rapid step input response**
- ☆ **Linearity of 0.05%**

The true differential response of the Type 190 provides increased accuracy and simplified installation for data reduction, control, and similar applications. With infinite rejection of common d-c signals, and a rejection ratio at 60 cps of the order of a half million, errors due to ground currents are completely eliminated, and pickup problems greatly diminished.

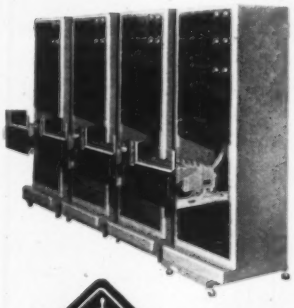
The Type 190 is designed for fixed-gain operation from low impedance sources, into high impedance load. Gain may be set at values ranging from 160 to 1200. Amplifier characteristics are unchanged at ambients from −67°F to +170°F.



Four Type 190 Amplifiers mounted in BM190 modular rack unit with Type 390 power supply.

Price of Type 190 Amplifier.....$325
Type 390 Power Supply, for up to four Type 190 Amplifiers.....$250
Type BM190 Rack Unit for four Type 190 Amplifiers and Type 390 Power Supply.....$140

Ask for bulletin No. 572 giving full technical information



OFFNER DYNOGRAPH Direct-Writing Oscillograph

Zero-drift d-c recorder with microvolt sensitivity. One amplifier type covers all requirements.

Models for one to 19 channels.

Rectilinear or curvilinear recording.

ON DISPLAY BOOTH 212 I.S.A. SHOW

Ask for bulletin No. L-861

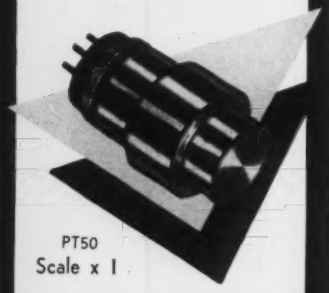
OFFNER ELECTRONICS INC.

5320 N. Kedzie Avenue, Chicago 25, U.S.A.

For more information circle **96** on inquiry card.

Dynisco

PRESSURE PICKUP



PT50
Scale x 1

Incorporates
Unbonded Strain Gage

HIGHLIGHTS

FLUSH MOUNTED DIAPHRAGM

HIGH NATURAL FREQUENCY

ACCURACY 1% MAX

MINIATURE SIZE

TEMP. RANGES —65° to 250°F

STAINLESS STEEL CONSTRUCTION

PRESSURE RANGES 0-10 to 0-1000 psi
PRICE: $125.

For more information on Dynisco pressure, force, flow pickups, write:

DYNAMIC INSTRUMENT CO.
28 Carleton Street
Cambridge 42, Mass.

For more information circle **97** on inquiry card.

NEW INSTRUMENTS

photometers, dc amplifiers, etc., where requirements are severe. Output is 6 v adjustable ±5%, 0-5 amp; or 2 v adjustable ±5%, 0-100 ma. Ripple and noise at 6 v output is 1 mv rms max (at 2-v 0.5 mv rms max). Recovery time 0.001 sec (63%). Line regulation 0.01% max; no-load to full-load regulation 0.05% for 6-v output and 5% for 2-v output.—*American Electronic Labs., Inc., 121 N. 7th St., Phila., Pa.*

For more information circle **277** on inquiry card.

VOLTAGE MONITOR FOR POWER SUPPLIES

New Series 2303 Compacts contain a VHS Meter-Relay, load relay and

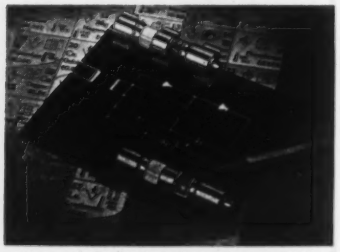
other components for continuous monitoring or control of voltage supplies. —*Assembly Products, Inc., Palm Springs, Calif.*

For more information circle **278** on inquiry card.

RECTIFIERS

VOLTAGE DOUBLER RECTIFIERS

New dual-purpose silicon cartridge voltage doubler rectifiers, especially applicable to airborne military equip-

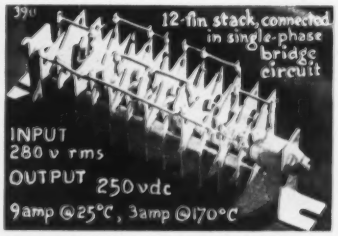


ment, and industrial equipment operating in high ambient temperatures (−55°C to 150°C), are sealed for use in corrosive atmospheres. Each rectifier is a voltage doubler having a maximum rating per leg of 3,200 piv. Therefore, two units can be connected as a single-phase, full-wave bridge, capable of delivering 1,900 vdc @ at 90 ma. for an input voltage of 2,240 vrms @ 75°C.—*International Rectifier Corp., El Segundo, Calif.*

For more information circle **279** on inquiry card.

SILICON RECTIFIER STACKS

New series of 170°C silicon rectifier stacks, added to GE line of semiconductor rectifiers, includes over



200 standard models which are completely pre-assembled rectifier circuits needing only two screws for mounting and connection of electrical contacts for operation.—*General Electric Co., Semiconductor Products, Clyde, N. Y.*

For more information circle **280** on inquiry card.

GERMANIUM POWER JUNCTIONS

New liquid-cooled germanium power junctions, rated at 670 amps rectified dc, provide 98.5% efficiency and

appreciably lower power consumption of rectifier equipment Connected in a 3-phase bridge circuit, six will deliver 170 kw (2,000 amps at 85 v.)—*International Rectifier Corp., 223 Kansas St., El Segundo, Calif.*

For more information circle **281** on inquiry card.

RESISTORS

VERNIER VDR

New Type 29-A Verni-Pot variable resistor requires only two turns of control knob to cover full scale of two resistance decades which provide range and resolution equal to a conventional 10-turn helical unit. It can

You don't have to be over 21

to install and maintain

a Fenwal temperature indicating controller

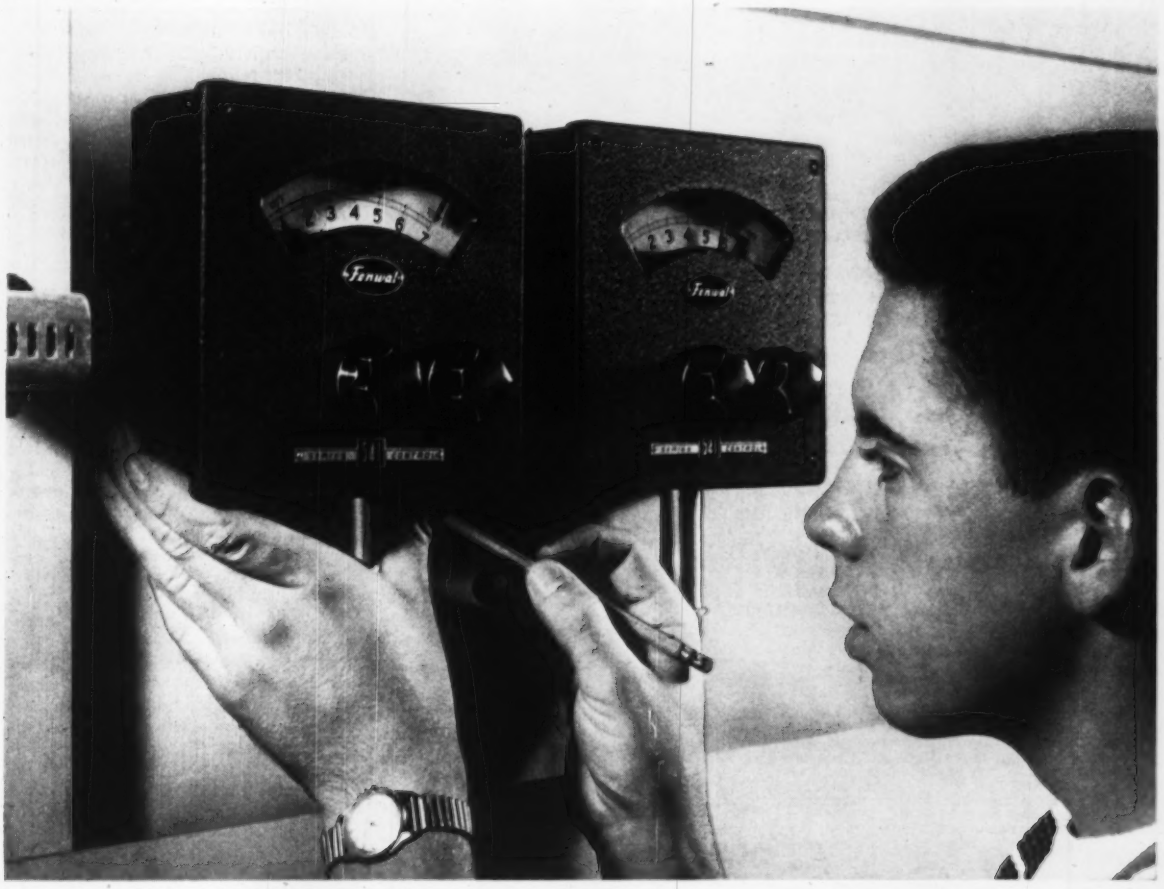
It really is a cinch for an untrained person to install and maintain Fenwal's 541 Temperature Indicator Controller. You don't even have to open the case to adjust it — even its snap switches can be easily replaced without disturbing the internal mechanism. *It's simple!*

In Fenwal's 541 all moving parts are in opposition — wear on one is automatically compensated for and the controller's high accuracy remains unchanged! *It's reliable!*

You can take your choice of temperature range, bulb styles, and one or two circuit controls, current ratings — even the color of the housing. There are literally hundreds of adaptations that can be made from stock! So you get a tailor-made, fit-to-order controller at a competitive price! *It's versatile!*

Drop us a line at Fenwal Incorporated, 369 Pleasant Street, Ashland, Mass. and we'll send you our catalog MC-139 or our sales engineer, whichever you want.

This is our dual circuit model (we've got hundreds of others) which has two snap switches, each with a set point indicator, that actuates two circuits at pre-set temperatures. Housing in all Fenwal 541's meet NEMA and JIC specifications.



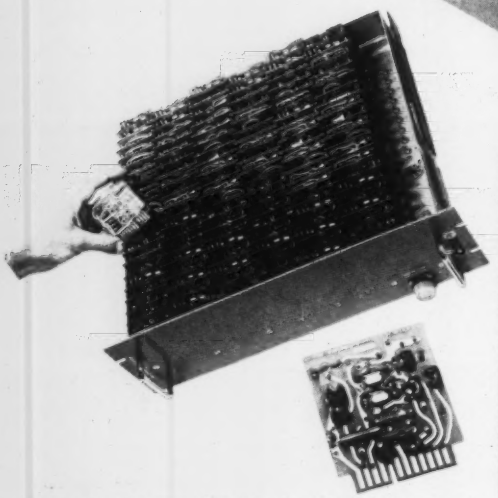
Fenwal CONTROLS TEMPERATURE . . . PRECISELY

For more information circle **98** on inquiry card.

NEW EECO Silicon TRANSISTOR PLUG-INS

-40° C to +100° C

for extremely reliable ground and airborne equipment



This is the first **complete line** of transistorized systems components offering hermetically sealed **silicon** semiconductors and components.

Check these features:

- Operate reliably in ambient temperature range of −40°C to +100°C.
- Smaller, more compact (mounted on 2-7/8" x 2-9/16" x 1/16"-thick epoxyglass); still incorporating more components.
- Power supply requirements ±20 Volts.
- Plug into any standard 12-contact etched-circuit connector.
- All plug-in contacts rhodium-plated for long life and trouble-free service.
- Complete supply of compatible systems hardware.

CIRCUITS: The complete line of EECO **Silicon** Transistor Plug-in circuits includes:

FLIP-FLOPS	**EMITTER FOLLOWERS**
ONE SHOTS	**SQUARING CIRCUITS**
NEON DRIVERS	**LINEAR AMPLIFIERS**
RESET GENERATORS	**BLOCKING OSCILLATORS**
DIODE LOGICS	**and many others.**

NEW EECO RUGGEDIZED STANDARD-SERIES PLUG-INS

The full line of tested and proven circuits available in EECO's Standard-Series Plug-ins has been ruggedized for even greater reliability and more efficient performance.

Each unit now incorporates the IERC Shield to:

- Protect tube from vibration and shock.
- Dissipate heat more effectively.
- Ensure longer tube life with cooler, more efficient operation.
- Provide even greater electrical shielding.

New mechanical construction and design assures full protection to critical components against stress or tension.

All ruggedized units are compatible with EECO Standard-Series hardware and EECO Systems Development Racks.

NEW CIRCUITS include High-Speed Flip-Flops, Oscillators, etc., in both Computer-Series and Standard-Series Plug-ins . . . plus other systems building blocks: D-C Chopper Stabilized Amplifiers, Power Supplies and Compatible Accessories, Systems Development Racks, Systems Components. Detailed information available in Catalog No. 856-A.

AVAILABLE SOON: New EECO Germanium Transistor Plug-ins. These EECO units will comprise a complete line of transistorized systems components, including a full complement of circuits (One Shots, Flip-Flops, Linear Amplifiers, Pulse Amplifiers, "And" Gates, "Or" Gates, and many others) as well as compatible systems hardware.

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For more information circle **99** on inquiry card.

NEW INSTRUMENTS

be used as either a voltage-dividing resistor or rheostat without modification and is available in standard resistance values of 1000, 10,000, and 100,000 ohms (other values to special order). Full-scale resistance accuracy 0.1%; resolution 0.02% or better; power rating 3 watts max when used as a VDR and 20 ma when used as a rheostat.—*Research Instrument Corp., 7962 S. E. Powell Blvd., Portland 16, Oregon.*

For more information circle **282** on inquiry card.

SUBMINIATURE RESISTORS

New molded composition resistors in 0.1-watt size have been added to maker's line of 0.5, 1, and 2-watt

"Little Devil" units. Lead wires are molded solidly into resistance material for reliable electrical connection, and are hot-solder-coated for rapid soldering. RETMA values from 100 ohms to 1.0 meghm, ±10% tolerance.—*Ohmite Mfg. Co., 3631 Howard St., Skokie, Ill.*

For more information circle **283** on inquiry card.

MOTORS, etc.

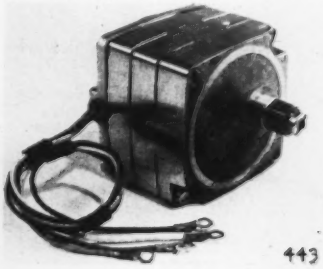
SHADED-POLE MOTOR

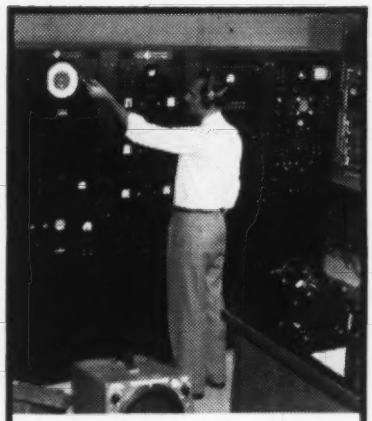
New "slim" shaded-pole motor is 33% lighter than previous designs. Length of two-bearing unit is less than 4"; weight 5.5 lb. First motor of its kind to provide ventilation openings in both shell and end shields without additional cost to customers. —*Specialty Motor Dept., General Electric Co., Schenectady 5, N. Y.*

For more information circle **284** on inquiry card.

INSTRUMENT MOTORS

Newly-redesigned chart-drive and two-phase balancing motors used principally in recorders, indicators and controllers provide improved performance and easier servicing; fea-





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For further information contact Mr. Robert A. Martin at the Waldorf Astoria Hotel anytime during the week of March 17. Phone ELdorado 5-4107. Or write the address below.

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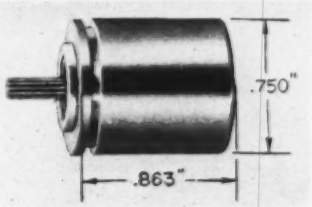
ture four die-cast aluminum housings bolted together into a square assembly, and felt wicks that prevent leakage of lube oils.—*Industrial Div., Minneapolis-Honeywell, Philadelphia 44, Pa.*

For more information circle **285** on inquiry card.

SMALL HI-TEMP SERVOMOTOR

New Type 8-5001-02 smaller lighter continuous-duty servomotor for transistorized operations has an

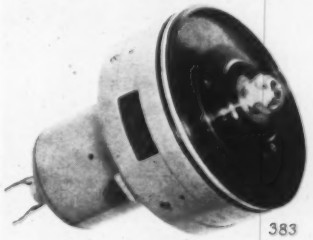


operating temperature range of −65°C to 125°C and meets MIL-E-5272. Voltage is 40/20 on control phase and 26 on fixed phase 400 cps. No-load speed 6500 rpm; stall torque 0.15 oz-in.—*John Oster Mfg. Co., Avionic Div., 1 Main St., Racine, Wis.*

For more information circle **286** on inquiry card.

MICRO POSITIONING SYNCHROS

Two new and larger Rotary Inductosyns (in addition to original 3" model): 7" model accurate to 2 sec-

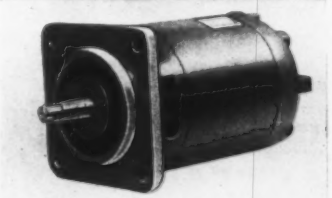


onds of arc and a 12" unit with 1-sec accuracy. Both are 360-pole, 180 speed (perform in a manner similar to that of a conventional resolver that has been geared up 180 to 1). Since ratio is gearless, it thus provides accuracies of a 180-speed system without errors inherent in a geared system.—*Farrand Controls, Inc., 4401 Bronx Blvd., New York 70, N. Y.*

For more information circle **287** on inquiry card.

AC MOTORS

New 3800 Frame Series ac motors, designed for induction, torque or hysteresis synchronous applications,



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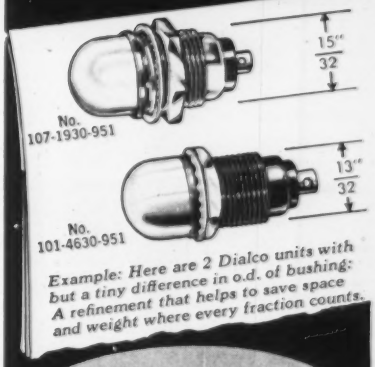

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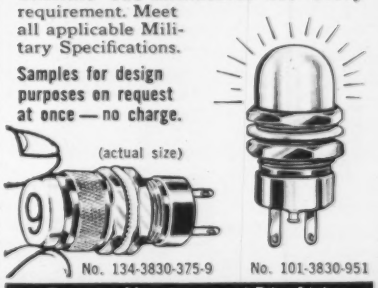

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For more information circle **100** on inquiry card.

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For more information circle **101** on inquiry card.

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For more information circle **102** on inquiry card.

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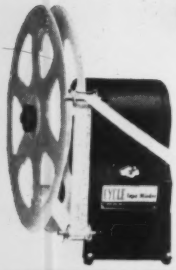

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For more information circle **103** on inquiry card.

NEW INSTRUMENTS

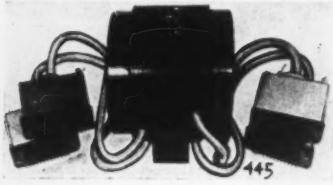
have outputs up to 1 hp; are available with input voltages of 26 to 230 vac, 1, 2 and 3 phase; input frequency from 25 to 400 cps. For induction applications, ouputs to 1 hp; torque motors 10 to 200 oz-in stall torque; hysteresis synchronous 1/200 to ¼ ph. Motors can be wound for single, dual or three speed; can be supplied as self-cooled with internal fan.—*Induction Motors Corp., 570 Main St., Westbury, N. Y.*

For more information circle **288** on inquiry card.

SWITCHES

SAMPLING SWITCHES

New Series 102 Models A-J high-speed sampling switches have miniature multipin connectors attached to

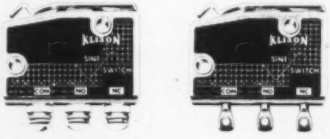


cables of convenient length; 2 to 8 poles and 60 to 170 shorting channels or 30 to 85 non-shorting channels per pole.—*General Devices, Inc., P. O. Box 253, Princeton, N. J.*

For more information circle **289** on inquiry card.

HIGH-TEMP SINE SWITCH

New KX5 miniature switch designed to operate continuously at temperatures as high as 375°F is a



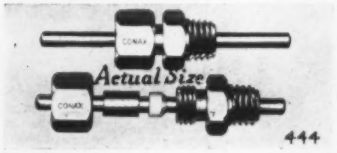
high-capacity type capable of withstanding severe environmental conditions. Switching element is Klixon Sine Blade.—*Spencer Thermostat Div., Metals & Controls Corp., Attleboro, Mass.*

For more information circle **290** on inquiry card.

MECHANICAL COMPONENTS

PACKING GLAND

New Micro Packing Gland can be used to seal tubes of any material because "soft" sealant makes it in-

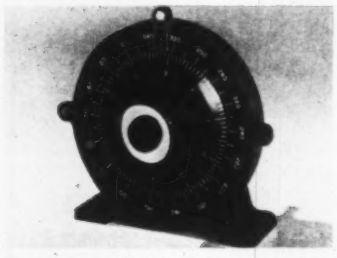


different to tube composition. Fatigue strength and resistance to vibration are assured by reduction of stress concentration at point of seal. Temperature range with Teflon sealant —90°F to 500°F and seal pressures from 0.005 micron up to 1000 psi. Using Lava sealant, —300°F to 185°F and 0.005 micron to 3000 psi. —*The Conax Corp., 2300 Walden Ave., Buffalo 25, N. Y.*

For more information circle **291** on inquiry card.

DIAL ASSEMBLIES

Two new concentric dial assemblies added to maker's standard electromechanical breadboard parts line:

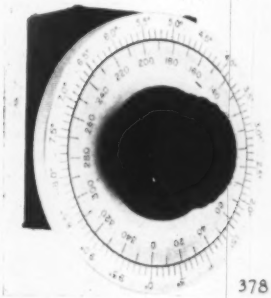


(1) BP-302-36, ¼" shaft, ratio 36:1, reading accuracy 3 minutes; (2) BP-302-100, ⅛" shaft, ratio 100:1, reading accuracy better than 2 minutes.—*Beckman-Helipot Corp., Newport Beach, Calif.*

For more information circle **292** on inquiry card.

DUAL SPEED DIALS

New shaft positioning mechanism is offered in spur-gear type for low to moderately high velocity ratios,



378

and in planetary type for extremely high velocity ratios. Both types feature freedom from backlash within rated torque output range. With standard 36-to-1 ratio a direct readability of 0.1° can be obtained and 0.05° can be easily estimated when outer dial has 100 divisions.—*Acton Labs, Inc., 533 Main St., Acton, Mass.*

For more information circle **293** on inquiry card.

TWIN TUBING

New Tygon twin tubing is color-coded (example, red and blue), comes in 10-ft or 25-ft lengths boxed. OD ⅜"; ID ¼". Suitable for oxygen, hydrogen, butane, etc., for glass shops, hand torches, etc.—*Bethlehem Apparatus Co., Inc., Hellerton, Pa.*

For more information circle **294** on inquiry card.

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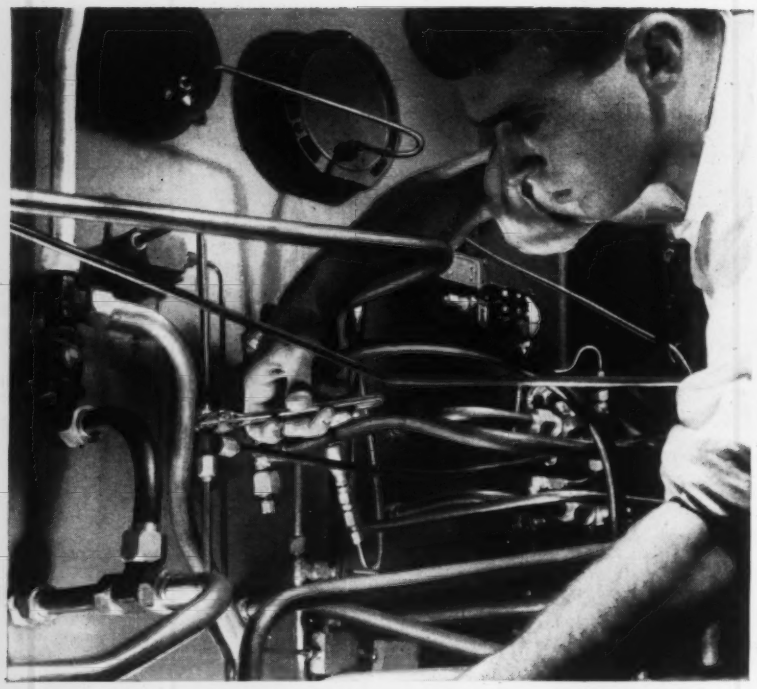

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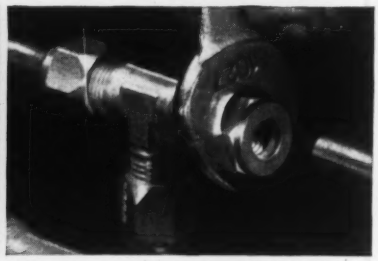
Weld-lok. Easy to use. Simply insert tube, then weld. For extreme temperatures or corrosion conditions — wherever permanently welded joints are needed. Available in steel and stainless steel. Send for Catalog No. 4370.



Intru-lok. 3-piece flareless design fitting especially for instrumentation lines of ¼" through 1" O. D., copper or aluminum. Easy to install. Just insert tube, then tighten with regular wrench. Also for plastic tubing. Catalog No. 4324.

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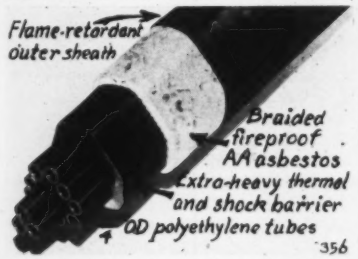
For more information circle **104** on inquiry card.

NEW INSTRUMENTS

TUBING HARNESS

New Dekoron Protecto-Pac fire- and impact-resistant instrument tubing features: multiple-tube construc-



tion; light and supple; can be installed at a fraction of cost of single or multiple-line conventional metal instrument tubing; flame-retardant; impact resistant. Available in increments of 100 ft or in 500-ft coils.—*Dekoron Products Div., Samuel Moore & Co., Mantua, Ohio.*

For more information circle **295** on inquiry card.

VALVES, ACTUATORS

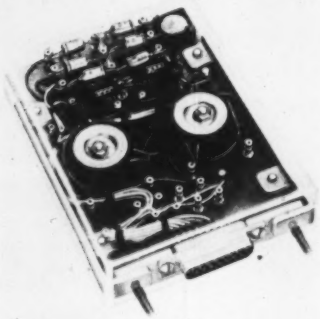
REMOTE POSITIONER

New Remote Mounted Positioner is a high-capacity relay pilot valve that converts any high-grade commercial cylinder to a double-acting actuator. It converts input air signals (0-30-psi standard) to pneumatic or hydraulic signals up to 150 psig. It enables user to choose the most desirable power cylinder with regard to bore, stroke, and mounting style.—*Hagan Chemicals and Controls, Inc., 323 Fourth Ave., Pgh. 22, Pa.*

For more information circle **296** on inquiry card.

HYDRAULIC-VALVE MAG AMP

New magnetic amplifier for hydraulic valves features high gain and fast response in single-stage unit by

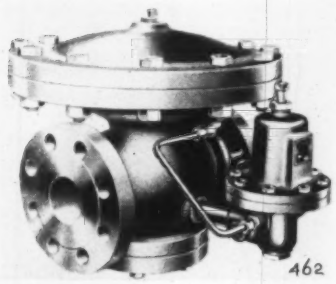


operating at a supply frequency of 5000 or 3600 cps. Characteristics are such that a complete high-performance electrohydraulic servo loop can be achieved without additional amplifying elements.—*Magnetic Amplifiers, Inc., 632 Tinton Ave., New York 55, N. Y.*

For more information circle **297** on inquiry card.

PILOT-OPERATED VALVE

New Type 92B is an improved version of maker's pilot-operated reducing valves for steam service. It ob-

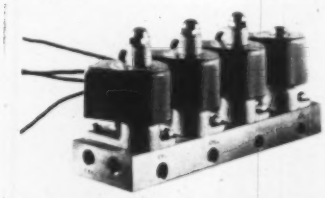


tains pilot operating medium directly from inlet; minimizes problems inherent in steam regulation such as clogged orifices, sticky valves and diaphragm rupture.—*Fisher Governor Co., Marshalltown, Iowa.*

For more information circle **298** on inquiry card.

MANIFOLD VALVES

New midget 2-way and 3-way solenoid valves are for manifold mounting on a common body. Any combina-

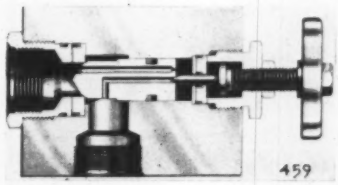


tion of 2- and 3-way valves can be used when operated from a common pressure and return line. Valves can be mounted in any position; are suitable for air, gas, water, light oil, refrigerants, etc., up to 212°F and 300 psi.—*Automatic Switch Co., Florham Park, N. J.*

For more information circle **299** on inquiry card.

METERING VALVE

New Throttle-Flo 5000-psi pilot-type 1" (-16) size throttling valve features low turning torque: operator

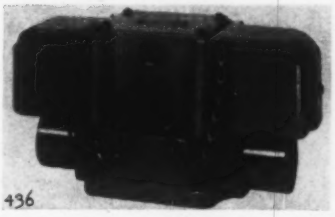


adjusts a small needle valve to obtain proper flow. Full flow is obtained by 2½ turns of pilot valve, yet metering is accurate to 0.01 gpm through valve's entire range. A positive seal is maintained under critical conditions. To reduce ports to smaller sizes, standard AN adapters can be used.—*Republic Mfg. Co., 15655 Brookpark Rd., Cleveland 11, Ohio.*

For more information circle **300** on inquiry card.

SMALL 4-WAY VALVES

New small solenoid-controlled pilot-operated 4-way valves fill void between ¼" and ¾"; are available as

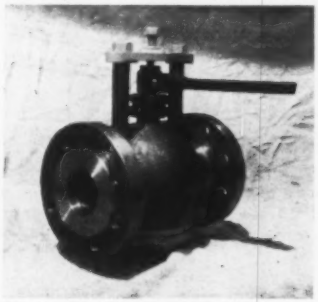


double-solenoid no-spring, single-solenoid spring-offset, and double-solenoid spring-centered. Same solenoids can be used throughout circuit where different sized valves are used. It is even possible to use new valve as pilot section of maker's 1¼" and 1½" valves.—*Double A Products Co., Manchester, Mich.*

For more information circle **301** on inquiry card.

EIGHTH-TURN VALVE

New Type No. 50 of maker's Chronometer Valve features a cone-shaped ported inner valve turning

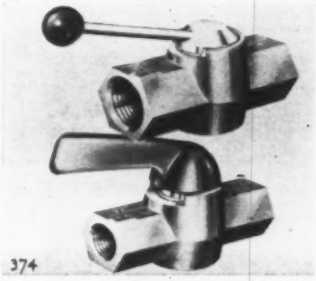


against inner ported dome of one-piece body. One-eighth turn of lever opens or closes. Sizes ½" to 4"; various body materials for pressures to 900 psi and for temperatures to 750°F.—*Defender Instrument and Regulator Co., Boody, Illinois.*

For more information circle **302** on inquiry card.

PLUG VALVES

New sizes in plug valves are now available: pipe sizes ¼", ½" and ¾"; ¼" size in stainless steel with



aluminum handle; other sizes in brass.—*Circle Seal Products Co., Inc., 2181 E. Foothill Blvd., Pasadena, Calif.*

For more information circle **303** on inquiry card.

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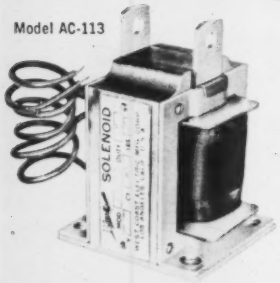
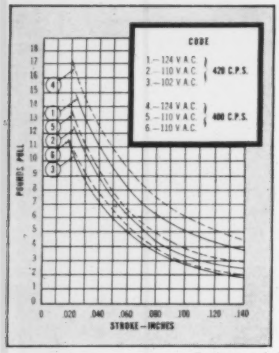
*Teflon—DuPont trade name for Tetrafluoroethylene resin

For more information circle **106** on inquiry card.

A WesCo special: 400 cycle HI-TEMP solenoid!

Model AC-113





WesCo's specially designed 400 cycle solenoid may help you solve your problem. Proven on latest military aircraft and other selective high temperature applications. Model shown is continuous duty, weighs 1 pound, tested to 600°F. Mounting furnished to meet your needs. Remember, when you need a solenoid, think of **WesCo.**

AC Industrial Solenoids—full line. Write for brochure.

DC Aircraft Solenoids—send specifications or write for catalog.

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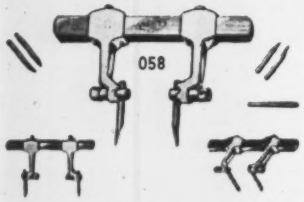
For more information circle **107** on inquiry card.

Eliminate makeshift or expensive special jigs with the . . .

ROLYN

ADJUSTABLE Key Spanner



An indispensable tool for Scientific Instrument Makers, Repairmen, Engineers, Electricians, Wireless Mechanics, Motor Engineers.

Now you only need *one* tool for removing or securing Internal or External Locking Rings • Bushings • Collets • Thrust Collars • Internal Cells, countless other adjustments.

The Key Spanner is easily adjustable for diameter and depth giving a positively rigid action up to a maximum capacity of 3" diameter.

Price Postpaid **$27.90** (Includes 3 sets of keys)

Saves its cost in time saved and damage avoided.

Robert M. Lynn

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Established 1923

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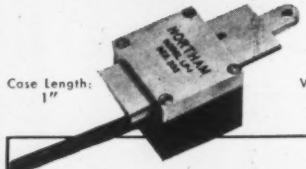
Address reply to Post Office Box 745, Arcadia, California

For more information circle **108** on inquiry card.

NORTHAM

LINEAR POSITION TRANSDUCER



Case Length: 1"

Weight: 4 oz.

For conversion of linear motion or position into an electrical output for remote indication, recording, and control. The instrument is of the variable inductance type and provides precise measurements under extremes of acceleration as well as under static conditions. All electrical components are rigidly embedded in the case, permitting operation under shock and vibration conditions.

MODEL LP-1 SPECIFICATIONS:

Range of Motion: . . . . ± ½ in. to ± 2 ins.
Accuracy: . . . . . ± 1% full scale
Excitation Frequency: From 60 to 20,000 cps

WRITE FOR BULLETIN NO. IA-1.

Northam Engineering Facilities Are Available To Assist You With Any Application Problems.

NORTHAM PRODUCTS INCLUDE . . .

Transducers for pressure, acceleration and displacement measurement and auxiliary electronic equipment for complete systems.

NORTHAM ELECTRONICS, INC.

A Subsidiary of Norris-Thermador Corp.

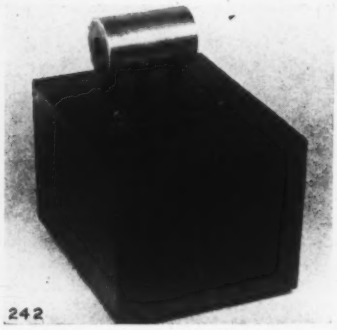
2420 North Lake Avenue, Altadena, Calif.

For more information circle **109** on inquiry card.

SHOP EQUIPMENT and SUPPLIES

MAGNET CHARGER

New Model 1221 Magnet Charger capacitor-discharge unit saturates two-pole permanent magnets up to

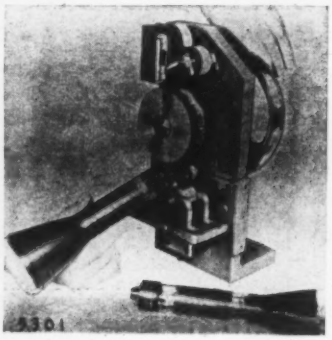


1½" long. Rated capacity 10,000 ampere-turns.—*Radio Frequency Laboratories, Inc., Powerville Road, Boonton, N. J.*

For more information circle **304** on inquiry card.

CATHODE-RAY TUBE MARKER

New Model 69-T cathode-ray tube marking machine imprints base of



tube by "Acroprene" molded die without slippage or smear.—*The Acromark Co., 3-11 Morrell St., Elizabeth, N. J.*

For more information circle **305** on inquiry card.

MARKING MACHINE

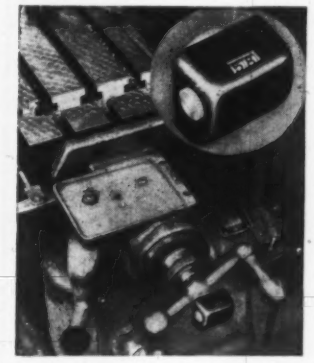
New high-cycle short-stroke Automark was developed for marking delicate aircraft parts; features many

light vibratory strokes (about 41 to 45 per second), as opposed to one heavy impact stroke.—*Defiance Machine & Tool Co., 1920 S. Vandeventer Ave., St. Louis 10, Mo.*

For more information circle **306** on inquiry card.

LEAD-SCREW REV COUNTER

New Lead-Screw Revolution Counter is for use with machine tools. Large numerals always give operator,

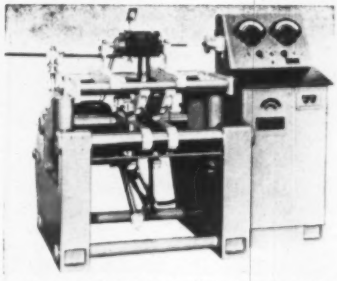


at a glance, the exact number of turns and allow for easy reading from any position.—*Pacific Transducer Corp., 11836 W. Pico Blvd., Los Angeles 64, Calif.*

For more information circle **307** on inquiry card.

BALANCING MACHINE

New static-dynamic balancing machine for parts up to 100 lb features a high-speed belt drive which rotates

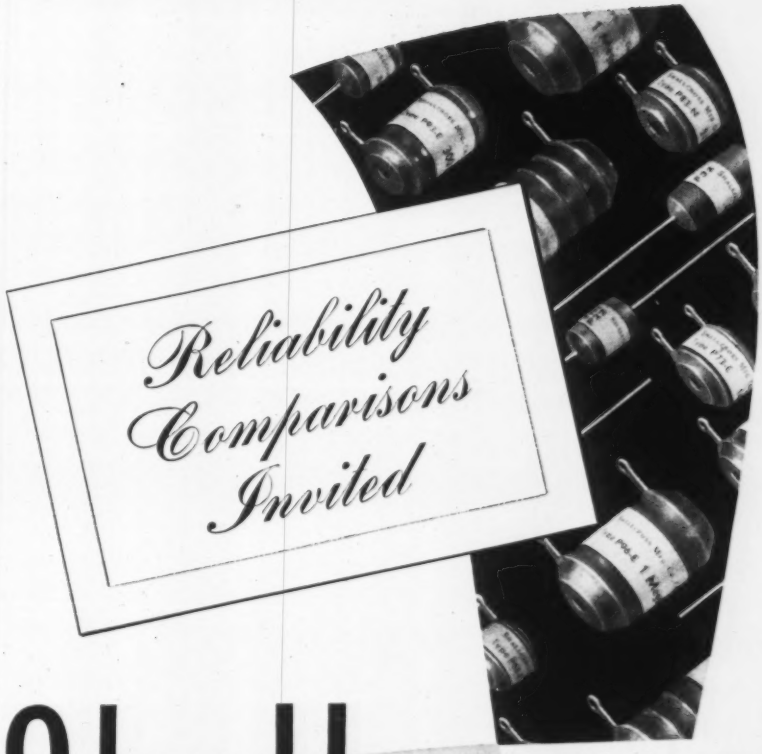


the part within the balancing machine bearings. Both angle and amount of unbalance are indicated on two instruments in control cabinet. Operator can change plane of correction instantly. Positive plane separation is assured.—*Tinius Olsen Machine Co., 6056 Easton Road, Willow Grove, Pa.*

For more information circle **308** on inquiry card.

SEALED TERMINALS

Two new high-voltage fused glass-to-metal hermetic terminals for transformer applications utilize maker's own specially-developed com-



Shallcross

PRECISION WIREWOUND RESISTORS

MIL-R-93A RESISTORS
. . . for 85°C ambients

MIL-R-9444 RESISTORS
. . . for 125°C ambients

This is your invitation to test and compare Shallcross precision resistors for that elusive quality known as reliability.

Statisticians tell us that component reliability and, subsequently, equipment reliability, can be predicted on a sound mathematical basis—assuming that environment is correctly predicted.

Unfortunately, most equipment manufacturers have divergent ideas of what component environments should be. Thus there are just as many interpretations of what constitutes a reliable component. In the absence of a common gage for reliability, Shallcross welcomes the opportunity of working with the standards and components groups now being established by many equipment manufacturers.

To save valuable testing time, Shallcross can supply qualified recipients with complete test data that shows to what extent MIL-R-93A is met or exceeded for any of eleven resistor styles. Data is also available on four of twelve Shallcross styles conforming to the 125°C MIL-R-9444 Specification. Data on remaining styles will be available as scon as testing is completed.

Details on Shallcross resistors designed to MIL Specifications as well as helpful application notes on encapsulated precision wirewound resistors are contained in newly-released Supplement to Bulletin L-30. For your copy write: **SHALLCROSS MANUFACTURING CO., 510 Pusey Ave., Collingdale, Pennsylvania.**

For more information circle **110** on inquiry card.

ACCURACY

in modern scientific instruments often depends on controlling the direction of light without:

DISTORTION • DIFFRACTION

DIFFUSION

Consult the pioneers in evaporated metal coatings for:

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- semi-transparent mirrors metallic and non-metallic
- beam splitters
- optical filters

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For more information circle **111** on inquiry card.

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BURKE & JAMES has the most complete LENS service. Quality-control instrument shop, LENSKOTING dept., and your choice of special mountings. Lenses available on 10 DAY TRIAL.

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Ask about B & J's "Pay As You Use It" RENTAL PLAN.

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321 S. Wabash Chicago 4, Illinois

For more information circle **113** on inquiry card.

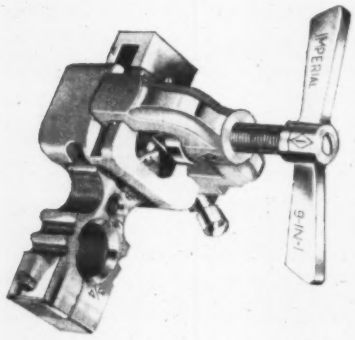
NEW INSTRUMENTS

pression glass (V-24) with a resistance of 100,000 megohms at 150°C; are rated at 3500 and 5000 v rms (highest voltages yet developed in this type of terminal; previous ratings stopped at 3000 v rms). Both terminals can be soldered on high-speed production lines. They meet all MIL-T27 specs for humidity cycling, torque, and bend testing.—*Fusite Corp., 6000 Fernview Ave., Cincinnati 13, Ohio.*

For more information circle **309** on inquiry card.

9-IN-1 FLARING TOOL

New 900F wide-range flaring tool makes 45° flares to SAE standards on 9 sizes of soft copper, utilizes a



rotating die bar to provide for the 9 sizes (⅛" to and ¾" O.D.) in minimal space.—*The Imperial Brass Mfg. Co., 1200 W. Harrison St., Chicago 7, Ill.*

For more information circle **310** on inquiry card.

LAB EQUIPMENT

ELECTRONIC DENSITOMETER

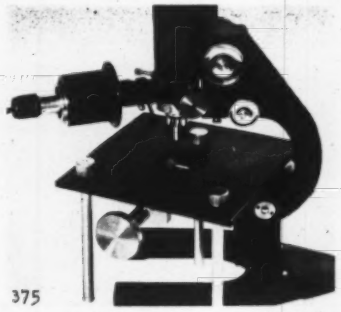
New Model 12A Macbeth-Ansco Electronic Densitometer features: Direct reading in linear density scale,

0 to 4.0 in color; all-new fundamental optical system; electronic zeroing; separate zero adjustments for each color filter; separate calibration circuit for reflectance density-measurements and transmission density measurements.—*Macbeth Instrument Corp., P. O. Box 950, Newburgh, New York.*

For more information circle **311** on inquiry card.

STRAIN VIEWER

New Flinn Strain Viewer, for microscopic (to 1000X) examination of solids under stress, comprises a



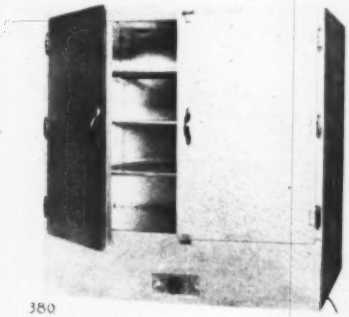
375

specimen table with a knife-edge loading device for transverse loading of a miniature polished bar. Specimen table legs can be removed if table is to be placed on stage of a metallurgical microscope.—*Harry W. Dietert Co., 9330 Roselawn Ave., Detroit 4, Mich.*

For more information circle **312** on inquiry card.

STERILIZING OVENS

New models of sterilizing ovens feature grey hammertone enamel on oven steel. Model 5562 (most expen-



380

sive of the five models) has three shelves, is thermostatically controlled, has inside working area of 36" W x 24" D x 24" H, double doors with no center post.—*National Appliance Co., Portland, Oregon.*

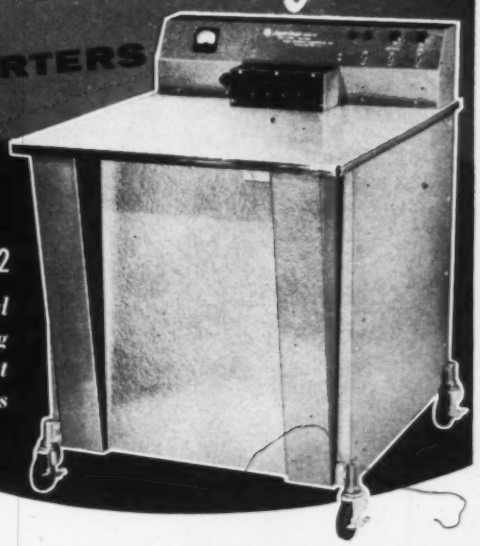
For more information circle **313** on inquiry card.

MULTI-PURPOSE STOPPER

New Pluro rubber stopper, for use in lab and in glass blowing, will fit as many as seventeen different size

448

from Magnet Charger HEADQUARTERS



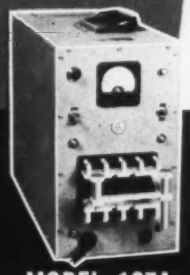
MODEL 942

Recommended by Leading Magnet Makers

3 VERSATILE MODELS

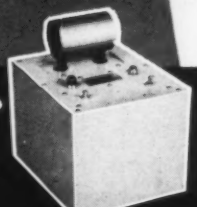
For saturating Alnico magnets weighing up to 34 lbs. and high flux ceramic magnets of any shape or pole configuration. Operates on condenser discharge principle from regular 115-volt, 60-cycle line.

Charging outputs from 100,000 to 200,000 ampere-turns through plug-in transformers, up to 3600 watt-seconds using wire-wound fixtures. Adapters for multi-pole rotors, rod, bar, ring and various other shapes available. Designed for continuous production use with low power consumption. Price of basic unit is less than $2100.



MODEL 107A

A basic condenser discharge unit for most medium size magnets, the Model 107A provides ranges of 12,000 and 24,000 ampere-turns. It is capable of saturating most instrument magnets, including the new core type mechanisms, using adapters or wire-wound fixtures. Designed for continuous duty. Operates from 115-volt, 60-cycle line. Price $530.



MODEL 1221

A low cost, condenser discharge unit employing novel, plug-in wire-wound type charging fixtures, the Model 1221 is designed for the user of small magnets. Its 10,000 ampere-turn output will saturate about 2" of Alnico V. Charging cycle rate is approximately 3 seconds, continuous duty, operates from 115-volt line. Price $180.

Performance of all models is rigidly guaranteed. Prices are net f.o.b. Boonton, N.J. and subject to change without notice.

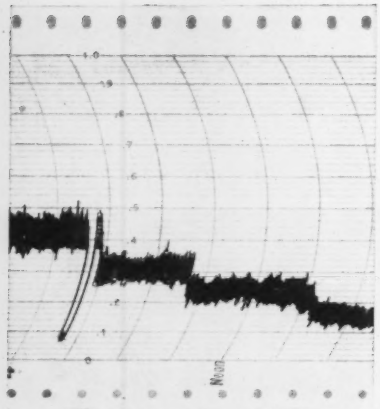
WE CAN HELP YOU

12 years' magnet charging experience is yours for the asking—send for illustrated data sheets.

RFL Radio Frequency LABORATORIES, INC. Boonton, New Jersey, U.S.A.

For more information circle **114** on inquiry card.

RECORDERS WORK... WHILE YOU ARE BUSY ELSEWHERE



Courtesy Nuclear Measurements Corp., Indianapolis, Indiana

This record was made by a DC Milliammeter in a monitoring unit, measuring fall-out over Indianapolis after the explosion of an experimental bomb.

The recorder was on the job continuously for 1½ days before fall-out began to increase as shown here. Meanwhile the technicians and engineers were busy at other tasks.

Make recording instruments help you multiply your effectiveness. Ask for Catalog 657.

Product Representatives in Most Principal Cities

The ESTERLINE-ANGUS Company, Inc.

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Flow Visualization Instrumentation

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CABLE CLIPS

★ *of all Nylon* for severe conditions ★ *of Ethyl Cellulose* for maximum economy

WECKESSER

molded Black Nylon **SCREWS and NUTS**

★ Acid resistant ★ Need no insulation ★ Can't rust ★ Can't corrode

WECKESSER COMPANY

5703 Northwest Highway • Chicago 30, Ill.

For more information circle **117** on inquiry card.

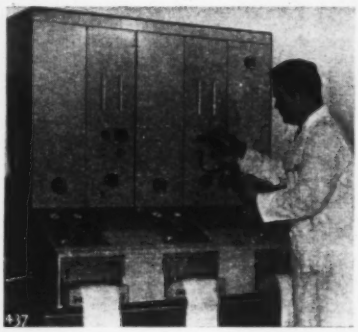
NEW INSTRUMENTS

openings, from 22 to 100 mm. It is essentially a Size 15 (4") stopper sliced into seventeen concentric tapered rings. Each ring or group of rings can be added to or subtracted from the core until desired fit is obtained. All rings nest snugly with a vacuum-tight fit.—*Bethlehem Apparatus Co., Inc., Hellertown, Pa.*

For more information circle **314** on inquiry card.

VAPOR FRACTOMETER

New triple-stage vapor fractometer makes possible for the first time the single-run analysis of a sample con-



taining a large number of components which boil over a wide range, hence is applicable to more research and industrial problems than are previous fractometers or other analytical procedures.—*Instrument Div., Perkin-Elmer Corp., Norwalk, Conn.*

For more information circle **315** on inquiry card.

INFRARED SAMPLE CELL

New low-cost variable thickness infrared sample cell for cancellation of background solvent absorption in in-

frared spectroscopy is for use with maker's Infracord double-beam infrared spectrophotometer but can also be used with maker's Models 13 and 21. Its thickness can be varied from 0.015 to 6 mm (sample volume 2 to 10 cc). Reproductivity better than 2 microns; linearity 2% or better for cell settings of 50 microns and above.—*Instrument Div., Perkin-Elmer Corp. Norwalk, Conn.*

For more information circle **316** on inquiry card.

LAB MILL JAR

New AVJ special-purpose jar for use on lab roller mills has a high alumina body (96% Al_2O_3, Mohs hardness 9); is specially desirable in research requiring high batch purity, low pickup and minimum contamination. Available: AVJ-1G (1-gallon size) and AVJ-1Q (1-pint size) with bronze hardware and rubber or neoprene gaskets.—*McDanel Refractory Porcelain Co., Beaver Falls, Penna.*

For more information circle **317** on inquiry card.

NUCLEONICS

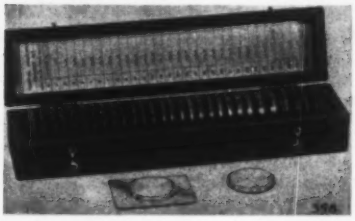
SCINTILLATION SPECTROMETER

New "Model 513" single-channel scintillation spectrometer, for qualitative or quantitative analysis of one or more isotopes in mixture, substantially reduces background count; can be used effectively for measurement of low-concentration or low-energy samples.—*Baird-Atomic, Inc., 33 University Road, Cambridge 38, Mass.*

For more information circle **318** on inquiry card.

CALIBRATED ABSORBER SET

New AB-2 calibrated Absorber Set establishes absorption curves for checking radiopurity of an isotope,

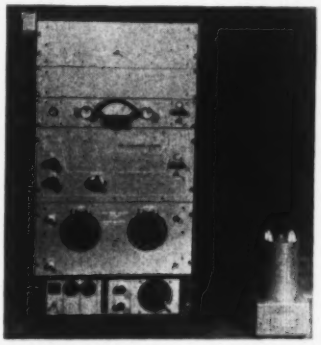


or estimating isotopic composition when energy difference of emitted radiation is sufficient. Set consists of 30 calibrated absorbers (25 aluminum and 5 lead) mounted in 1⅞" lucite rings to fit standard absorber trays, and carrier slide.—*Technical Associates, 140 W. Providencia Ave., Burbank, Calif.*

For more information circle **319** on inquiry card.

SCINTILLATION SPECTROMETER

New Model 516 single-channel scintillation spectrometer which counts only those pulses within pre-selected

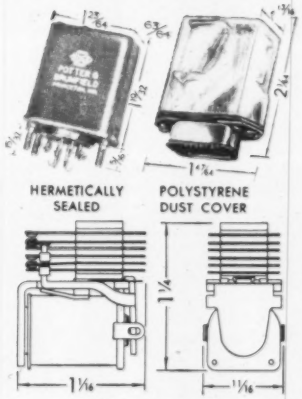


MINIATURE TELEPHONE TYPE RELAY HAS SUPERIOR SHOCK/VIBRATION RESISTANCE

Unusual for a telephone type relay, the MG Series has excellent stability under high shock and vibration conditions. Tests show this miniature, light weight (only 1.2 oz., open) relay withstands vibration of 10g 55 to 500 cycles per second and will operate under shock to 30g according to Mil-R-5757C.

The superior performance of the MG is due in part to its unique single stack construction and to an exclusive hinge design which provides zero heel gap.

Open, dust covered or hermetically sealed, the MG is available with contact arrangements up to 4 Form C (4PDT). It is rated for ambient temperatures of −55°C to +85°C. A high-temperature version with a range of −65°C to +125°C will soon be available. Write or wire today for complete specifications and delivery information.



MG RELAY

TERMINALS:
Open Relay: Pierced Solder Lugs.
Contacts: Two #18 AWG wires. Coil: Two #20 AWG wires.
Hermetically Sealed: Miniature plug-in header with 7, 9 or 14 pins. Multiple Solder header with hook and terminals for three #20 AWG wires.
Polystyrene Dust Cover: Micro Ribbon plug-in type. Mating receptacle: Amphenol #57-20140 or similar.
INSULATION RESISTANCE: 100 megohms min.
VIBRATION: .065" excursion 10-55 cps. 10g 55-550 cps. upon request.
SHOCK: 30g according to Mil-R-5757C upon request.
TEMPERATURE RANGE: −55°C to +85°C.
WEIGHT: 1.2 ozs. (open) 2.0 ozs. (sealed).
PULL-IN SPEED: Approximately 15 ms at nominal voltage.
DROP-OUT SPEED: Approximately 10 ms at nominal voltage.
CONTACTS: 3/32 silver.
CONTACT ARRANGEMENT: 4 pole, double throw (4 Form C).
COIL POWER: 3 watts max. DC @ 25°C. Continuous duty.

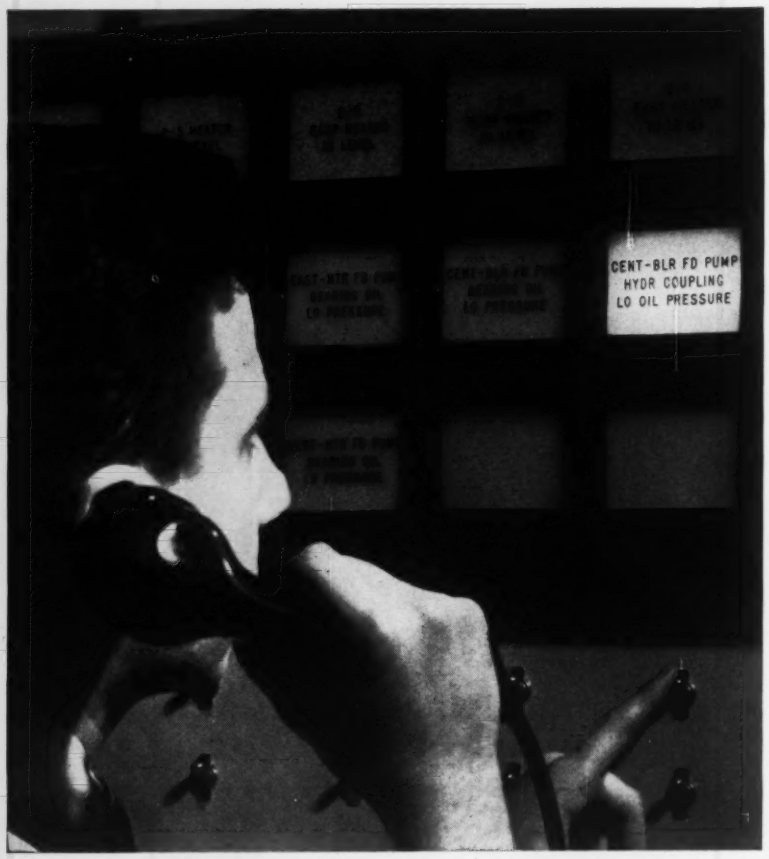
P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC, ELECTRICAL AND REFRIGERATION DISTRIBUTORS

Potter & Brumfield, inc.

PRINCETON, INDIANA

SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY
Manufacturing Divisions also in Franklin, Ky. and Laconia, N. H.

For more information circle **118** on inquiry card.



Panalarm Annunciator pinpoints process "off-normals"

In the process industries and among users of automatic machinery, trouble is minimized when it's caught early. That's the purpose of the Panalarm Annunciator System—a continuous monitor of your process.

One typical adaptation of the modular Panalarm system is engineered to differentiate between the first "off-normal" and subsequent "off-normals" caused by the first. This feature allows instantaneous recognition of the prime source of trouble in a "chain reaction."

Another adaptation is designed specifically for motor start-up and shut-down. It has also been successfully adapted for supervisory control, pump control and programming.

Your Panalarm sales engineer will be happy to make a survey of your requirements to determine whether a Panalarm system can aid productivity and safety in your process. For electrical and mechanical data on standard systems, request Catalog 100B on your letterhead.

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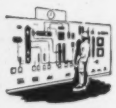
Panellit of Canada, Ltd., Toronto 14

Engineered Information Systems for Industry


Graphic Panels, Control Centers

Panalog Information Systems

Panellit Service Corporation

For more information circle **119** on inquiry card.

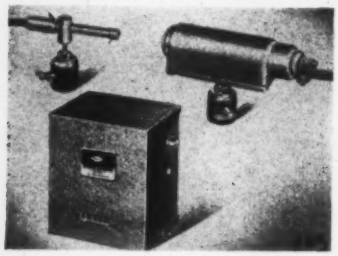
segments of the energy spectrum is designed to enable exploration of the spectrum in successive segments.—*Baird-Atomic, Inc., 33 University Road, Cambridge, Mass.*

For more information circle **320** on inquiry card.

MISCELLANEOUS

PHOTOELECTRIC CONTROLS

New "Robot-Eye" photoelectric controls have distinct advantages in installation due to miniaturization of



components. The highest standards of dependability and sensitivity have not been sacrificed to bring down the price.—*Standard Instrument Corp., 657 Broadway, New York 12, N. Y.*

For more information circle **321** on inquiry card.

CENTRIFUGAL DUST COLLECTOR

New centrifugal dust collector is claimed to have "the highest efficiency and lowest erosion rate of any mechanical dust collector on the market." Unique design of Venturi-spiral vaned nozzles, at inlet of each separating tube, effects an almost instantaneous sixfold increase in gas velocity, greatly intensifying tangential or outward thrust characteristics of centrifugal action.— *Hagan Chemicals and Controls, Inc., 323 Fourth Ave., Pgh. 22, Pa.*

For more information circle **322** on inquiry card.

MECHANICAL BTU METER

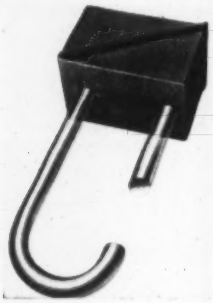
New Pollux B.T.U. Integrating Meter mechanical instrument measures heat in thermal units and liquid-

flow in gallons; can measure heat absorbed by a liquid and heat removed from the liquid.—*Air Conditioning Equipment Corp., 744 Columbus Ave., New York, N. Y.*

For more information circle **323** on inquiry card.

PHOTOELECTRIC PROBES

New photoelectric pickups for inaccessible locations feature light-conducting Lucite probes attached to a



case containing both phototube and light source. Probes are available in lengths up to 4 ft and "in practically any shape." Illustration shows arrangement for bin level control.—*Autotron, Inc., Box 722-Q, Danville, Ill.*

For more information circle **324** on inquiry card.

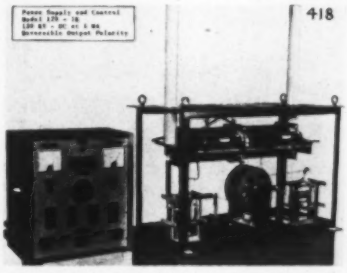
CAMERA-MICROSCOPE

New Ultraphot II (made in West Germany) combines camera, microscope and automatic exposure; provides for observing and photographing microscopic subjects in bright field, dark field and phase contrast, as well as with incident light, utilizing Koehler principle. Movable mirror system simulates bellows extension up to 12" and permits gradual magnification change from 6.5 to 1700.—*Carl Zeiss, Inc., 485 Fifth Ave., New York 17, N. Y.*

For more information circle **325** on inquiry card.

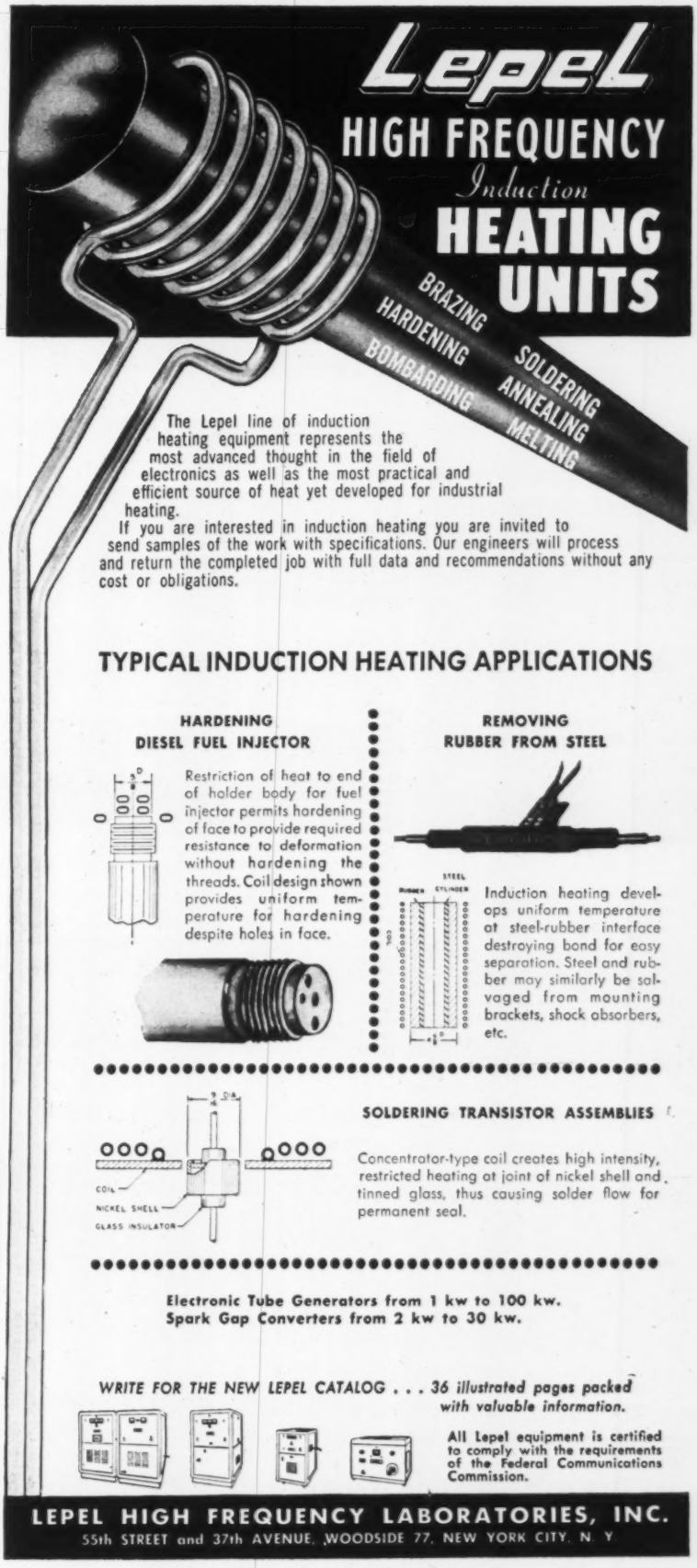
X-RAY EQUIPMENT

New special industrial x-ray sets for inspection, research, analysis and gaging, combine stand and compo-



nents and specially-designed units. Generating units are designed for operating requirements to inspect products from film thicknesses to heavy castings. Utilization of soft radiation of high intensity produced from specialized beryllium-window x-ray tubes makes possible refined inspection not hitherto performed. Example: examination of spot welds on thin aluminum sections. Full protection of operator.—*Bracke-Seib X-Ray Co., Inc., 293C Third Ave., New York 10, N. Y.*

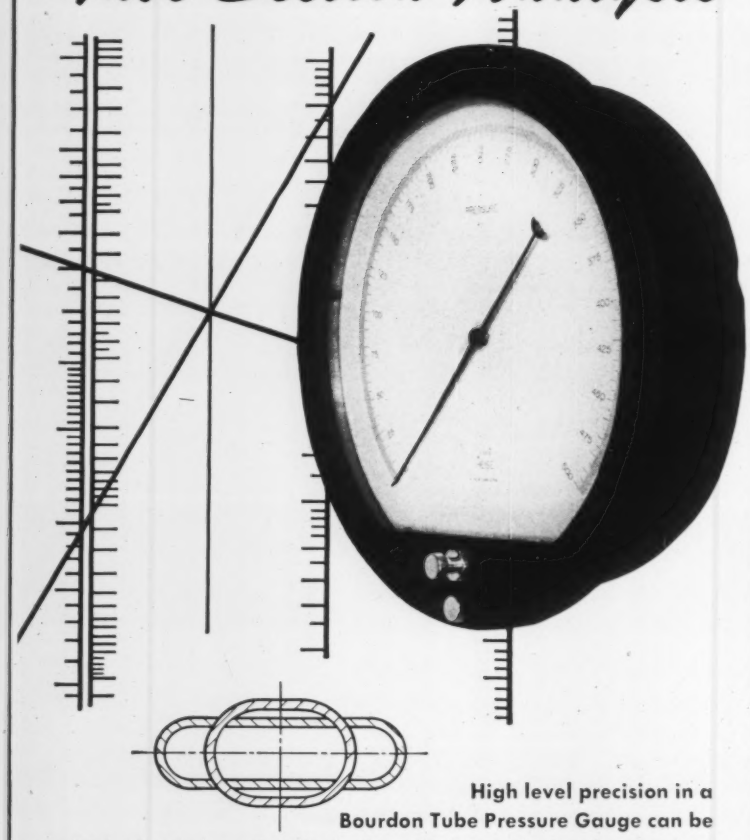
For more information circle **326** on inquiry card.


Lepel
HIGH FREQUENCY
Induction
HEATING
UNITS
BRAZING
HARDENING
BOMBARDING
SOLDERING
ANNEALING
MELTING
The Lepel line of induction heating equipment represents the most advanced thought in the field of electronics as well as the most practical and efficient source of heat yet developed for industrial heating.
If you are interested in induction heating you are invited to send samples of the work with specifications. Our engineers will process and return the completed job with full data and recommendations without any cost or obligations.
TYPICAL INDUCTION HEATING APPLICATIONS
HARDENING
DIESEL FUEL INJECTOR
Restriction of heat to end of holder body for fuel injector permits hardening of face to provide required resistance to deformation without hardening the threads. Coil design shown provides uniform temperature for hardening despite holes in face.
REMOVING
RUBBER FROM STEEL
STEEL CYLINDER
RUBBER
COIL
Induction heating develops uniform temperature at steel-rubber interface destroying bond for easy separation. Steel and rubber may similarly be salvaged from mounting brackets, shock absorbers, etc.
SOLDERING TRANSISTOR ASSEMBLIES
COIL
NICKEL SHELL
GLASS INSULATOR
Concentrator-type coil creates high intensity, restricted heating at joint of nickel shell and tinned glass, thus causing solder flow for permanent seal.
Electronic Tube Generators from 1 kw to 100 kw.
Spark Gap Converters from 2 kw to 30 kw.
WRITE FOR THE NEW LEPEL CATALOG . . . 36 illustrated pages packed with valuable information.
All Lepel equipment is certified to comply with the requirements of the Federal Communications Commission.
LEPEL HIGH FREQUENCY LABORATORIES, INC.
55th STREET and 37th AVENUE, WOODSIDE 77, NEW YORK CITY, N. Y.

For more information circle **120** on inquiry card.

HEISE GAUGES

Tube Section Analysis



High level precision in a Bourdon Tube Pressure Gauge can be achieved only by scientific design of tube section and scrupulous selection of material.

The Bourdon Tube is a hollow, curved beam acted upon internally by fluid pressure in widely varying degree and affected, in some applications, by broad temperature ranges. Uniform distribution of displacement throughout the gauge range and precise control of induced stress requires individual analysis of each gauge application.

Using data and formulas developed by their own laboratory, Heise engineers specify a length-width ratio, wall thickness and all information for maximum performance in each application of their gauges.

Pressure Ranges 15 to 20,000 P.S.I. Dial Sizes 8½"-12"-16"

Prices from $151.60 **DELIVERY WITHIN 30 DAYS**

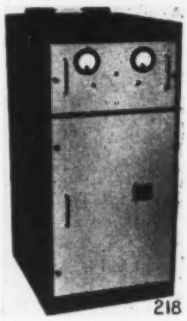
HEISE BOURDON TUBE COMPANY, INC.

BROOK ROAD, NEWTOWN, CONNECTICUT, U.S.A.

For more information circle **121** on inquiry card.

NEW INSTRUMENTS

AC VOLTAGE REGULATOR

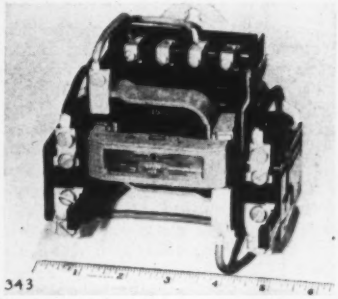


New regulator is said to be ideal for analog computers or similar uses where waveform distortion of input power can cause serious noise problems; has autotransformer driven by a high performance servo system. —*Commercial Products Division, Reeves Instrument Corp., 215 East 91st Street, New York 28, N. Y.*

For more information circle **327** on inquiry card.

MAGNETIC MOTOR STARTER

New NEMA Size 0 and 1 magnetic motor starter is 42% smaller than previous open forms, is of "snap-

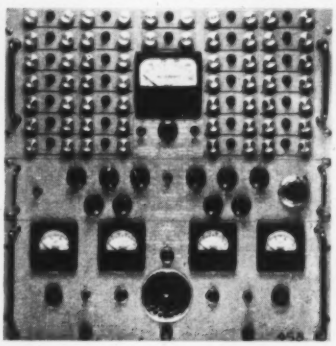


slide" construction: principal components simply snap or slide together for quick inspection and maintenance. Contacts can be inspected in seconds, without tools.—*General Electric Co., General Purpose Control Dept., Schenectady 5, N. Y.*

For more information circle **328** on inquiry card.

DECOMMUTATOR

New Model TDS-30-1 27-channel decommutation system, for use in airborne or trailer-installed telemeter receiving stations and in portable ground check-out equipment, is self-contained in three assemblies: gating unit (top), pulse selector



(middle) and regulated power supply (bottom). Modular plug-in gating units allow quick replacement of faulty channels. Two spare gating units are maintained on standby for instant use.—*Arnoux Corp.*, 11924 *W. Washington Blvd., Los Angeles* 66, *Calif.*

For more information circle **329** on inquiry card.

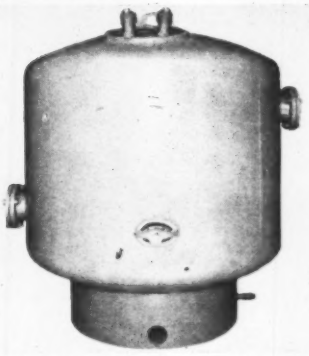
MEDICAL X-RAY FILM

New "Kodak Royal Blue Medical X-Ray Film" substantially reduces exposure times needed in making radiographs; has been tested extensively in hospitals and radiologists' offices in various parts of the country.—*Eastman Kodak Co., Rochester* 4, *N. Y.*

For more information circle **330** on inquiry card.

DEHUMIDIFIER-FILTER

New large-capacity Model 5000, added to line of Vi-Speed Dehumidi-Filters for compressed air systems,

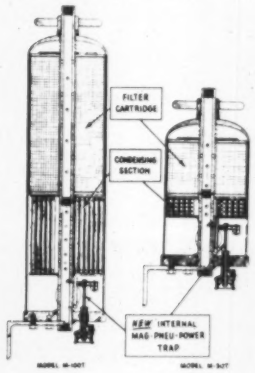


has a capacity for filtering 1700 scfm at 100 psi. Furnishes low-dewpoint air for instrumentation and other demanding uses.—*Van Products Co., 5700 Swanville Rd., Erie, Pa.*

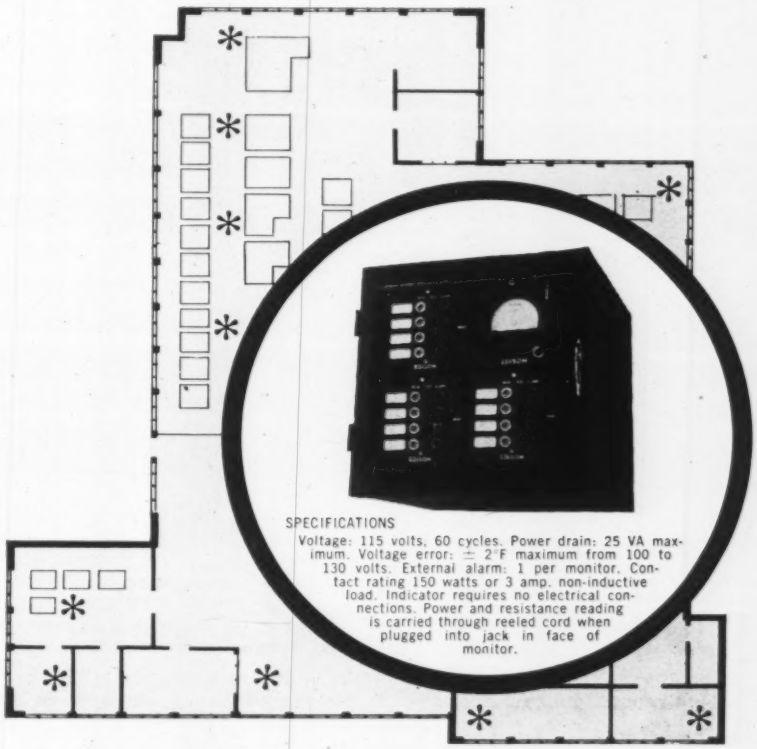
For more information circle **331** on inquiry card.

DEHUMIDIFYING FILTERS

New Models M-30T and M-100T Condensifilters are available with an internal Mag-Pneu-Power Trap. They now combine an internal condenser, disposable filter cartridge, and automatic condensate discharge in one



EDISON'S OMNIGUARD MONITORS CRITICAL* TEMPERATURES IN YOUR PLANT



SPECIFICATIONS
Voltage: 115 volts, 60 cycles. Power drain: 25 VA maximum. Voltage error: ± 2°F maximum from 100 to 130 volts. External alarm: 1 per monitor. Contact rating 150 watts or 3 amp. non-inductive load. Indicator requires no electrical connections. Power and resistance reading is carried through reeled cord when plugged into jack in face of monitor.

- VERSATILE — NEW CONCEPT OF ZONE MONITORING ALLOWS YOU TO PUT MONITOR UNITS WHERE YOU NEED THEM
- EFFICIENT — WARNS YOU BEFORE TROUBLE STARTS
- DEPENDABLE — NO MOVING PARTS ELIMINATE WEAR
- ECONOMICAL — COSTS LESS THAN ANY OTHER TEMPERATURE MONITORING SYSTEM YOU BUY MODULAR UNITS ONLY AS NEEDED

As few as four, and as many as several hundred critical temperature spots can be monitored at one central control panel or from local zone panels in your plant . . . with Edison's OMNIGUARD. Hot bearings, or excessive temperatures in oil lines, air ducts, and chemical processes can be visually checked at any time at any spot in your plant.

Here's how OMNIGUARD can save you a lot of money with a minimum of effort: just as soon as a critical temperature occurs at a point anywhere in your plant, the mechanism is automatically shut off, a warning bell rings and a lamp flashes on the monitor panel. Instantly the trouble source is pin-pointed, checked, and remedied . . . well in advance of otherwise costly trouble.

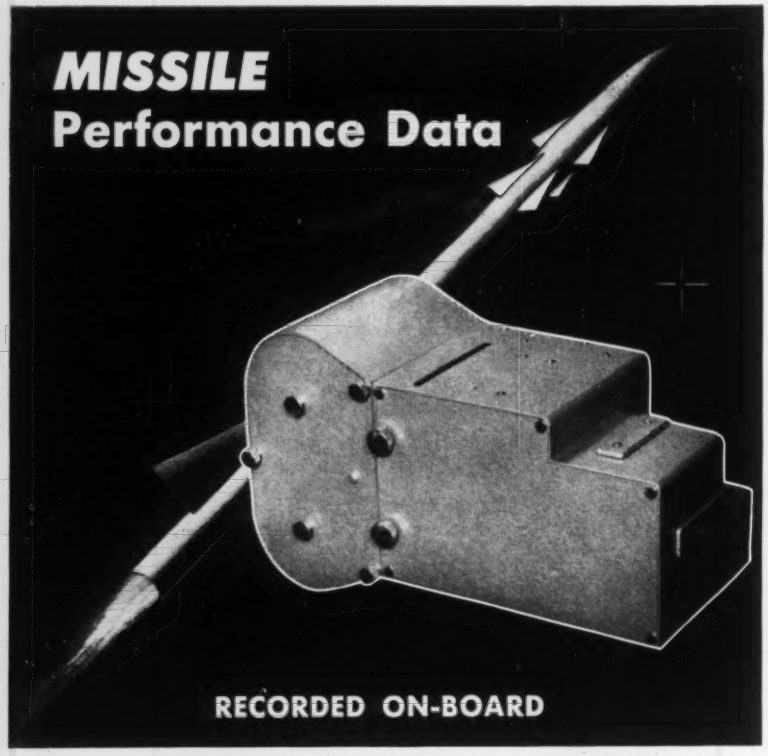
This entire Edison monitoring system uses no moving parts, except for the alarm relay contacts. No electronic tubes or expensive wiring between components is necessary. The actual detection is done with Edison Resistance Temperature Detectors, which signal the warning to OMNIGUARD.

Edison's Omniguard brochure, #3036A, gives the entire story on temperature monitoring. Write for it.

McGRAW EDISON

Thomas A. Edison
INDUSTRIES
INSTRUMENT DIVISION
WEST ORANGE, NEW JERSEY

For more information circle **122** on inquiry card.



CENTURY MODEL 409D RECORDING OSCILLOGRAPH

Numerous agencies engaged in the manufacture and evaluation of missiles have turned to the Century Model 409D Recording Oscillograph as a reliable means of collecting missile performance and control data.

On-board mounting eliminates the necessity for the costly and often not reliable RF link.

The ruggedness and reliability of this 12-channel oscillograph have been demonstrated many times. One agency reports having recovered 42 satisfactory record rolls out of 43 firings. Another, using special mounting configuration, reports recording at 60 G's without damage.

This 13 lb. instrument is compact enough to be installed in most missiles and all electrical connections including remote control are accomplished through a single multi-pin AN connector.

Wire, Write or Phone

CENTURY ELECTRONICS & INSTRUMENTS, INC.

1333 North Utica, Tulsa, Oklahoma

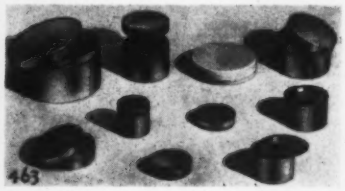
For more information circle **123** on inquiry card.

complete unit. They condense out moisture and oil vapors and filters out solid contaminants from compressed air and gas. Mag-Pneu-Power Trap, also sold as an external unit (Model 501), is a pilot-actuated power-operated mechanism that discharges condensate by using a combined magnetic-pneumatic action.—*Hankison Corp., 951 Banksville Rd., Pah. 16, Pa.*

For more information circle **332** on inquiry card.

SEAMLESS CANS

New seamless cans for storing, shipping, parts packaging, handling samples, etc., are available from stock



in many different shapes and sizes, or are made to order.—*George D. Ellis & Sons, Inc., American & Luzerne Sts., Phila. 40, Pa.*

For more information circle **333** on inquiry card.

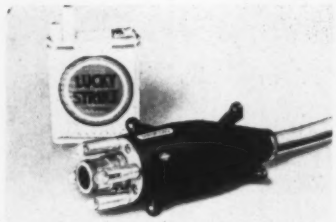
HYDRAULIC ACCUMULATORS

New line of piston-type accumulators for hydraulic service features important improvements over previous models. New design v-o-ring of synthetic rubber on piston provides long seal life and trouble-free sealing. Line includes 14 models ranging in oil capacity from 10 cu in to 10 gal, and 4 ID sizes from 2" to 7". All have SAE straight thread connection ports (adapters for other styles available); can be mounted in any position.—*Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.*

For more information circle **334** on inquiry card.

SMALLEST TV CAMERA

New miniature TV camera (made in West Germany) comes equipped with various lenses and mirror at-



tachments. Tiny spring-mounted wheels enable it to scan cramped locations such as inside small tubular vessels. Built-in lights solve lighting problems.—*Majestic International Sales, 79 Washington St., Brooklyn, N. Y.*

For more information circle **335** on inquiry card.

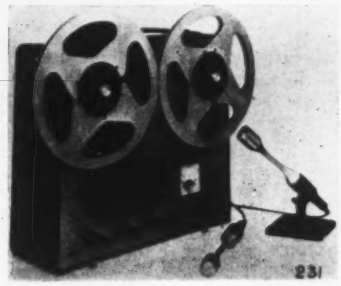
POINT-TO-POINT RADIO

New inexpensive MCA-474-B Three Channel Multiplex Station radiotelephone system bridges phone service over terrains where it would be physically or economically impractical to install phone lines; utilizes broadband point-to-point radio in UHF range of 450 MC; is suited for permanent and temporary telephone installations. Operation in UHF band makes it advantageously adaptable as a broad-band two-way radio system, a multi-channel radio communications unit (carrying up to 54 teletype channels), or as the transmission facilitates for slow-scan ITV.—*Allen B. Du Mont Labs., Inc., 750 Bloomfield Ave., Clifton, N. J.*

For more information circle **336** on inquiry card.

TAPE RECORDERS

New Series AV 100 lightweight tape recorders, for half-track or stereophonic record and playback, are of

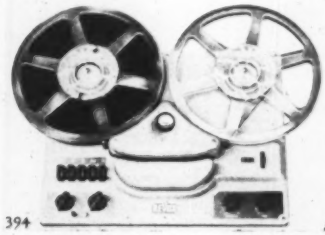


die-cast construction with three integral motors—one for tape drive and two for take-up. Push-button operation and safety erase interlock; accommodate reel sizes up to 10½"—*American Electronics Inc., 655 W. Washington Blvd., Los Angeles 15, Calif.*

For more information circle **337** on inquiry card.

TAPE RECORDERS

New Swiss-made ReVox tape recorders B-36-1 (single track) and B-36-2 (dual track) have 3 motors

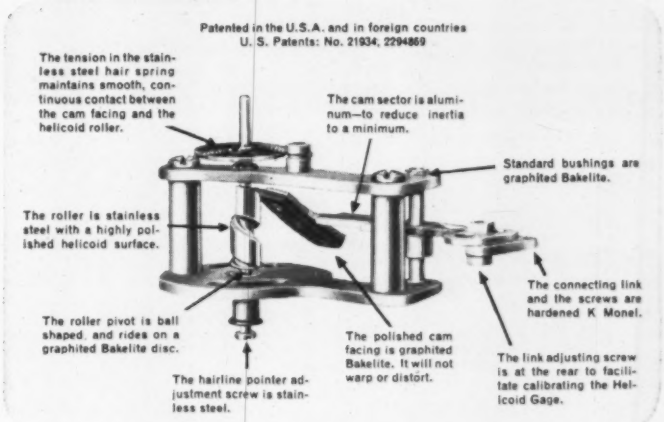


eliminating rubber belts, gears, friction rollers; separate recording and playback hard-alloy toroid heads; separate recording and playback amplifiers permitting simultaneous and continuous monitoring; high quality 8" coaxial speaker; and precision "turret assembly" wiring.—*Electronic Applications, 150 East 35 St., New York, N. Y.*

For more information circle **338** on inquiry card.

Nothing but the best in gages for working pressures from 30" vacuum to 10,000 p.s.i.

These details of Helicoid gage design assure longer life and enduring accuracy


Patented in the U.S.A. and in foreign countries
U. S. Patents: No. 21934, 2294869
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
The cam sector is aluminum—to reduce inertia to a minimum.
Standard bushings are graphited Bakelite.
The roller is stainless steel with a highly polished helicoid surface.
The connecting link and the screws are hardened K Monel.
The roller pivot is ball shaped and rides on a graphited Bakelite disc.
The polished cam facing is graphited Bakelite. It will not warp or distort.
The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
The hairline pointer adjustment screw is stainless steel.

The superiority of Helicoid Gages is most evident in severe service—wherever a gage is subjected to violent pressure pulsations or severe mechanical vibrations.

The *sustained accuracy* of Helicoid Gages over *millions of cycles* is explained by the details of design and construction of the Helicoid movement shown above. Such Helicoid features—protect against wear and corrosion and assure sensitivity, sustained accuracy and trouble-free operation.

Easiest adjustment and calibration

Only Helicoid Gages have the external pointer adjustment pictured here. The Helicoid type adjustment cannot be jarred out of position.

Calibration of Helicoid Gages is accomplished easily, without removing dial or pointer, because the link adjusting screw is at the rear of the system.

Tubes built for millions of pressure pulsations

To fit the wide range of applications, Helicoid Bourdon tubes are available in four materials—alloy steel, K Monel, stainless steel and phosphor bronze.

All Helicoid tubes are made from seamless tubing and are carefully designed to give maximum torque and minimum stress. When used within the dial range, they will withstand many millions of pressure pulsations and will not stretch, leak or crack.

For complete information on the Helicoid line of gages write for **Catalog G-52**

Helicoid gives you all these features at prices that are competitive in the quality gage field.

Helicoid Gage Division
AMERICAN CHAIN & CABLE

929-B Connecticut Avenue • Bridgeport 2, Connecticut

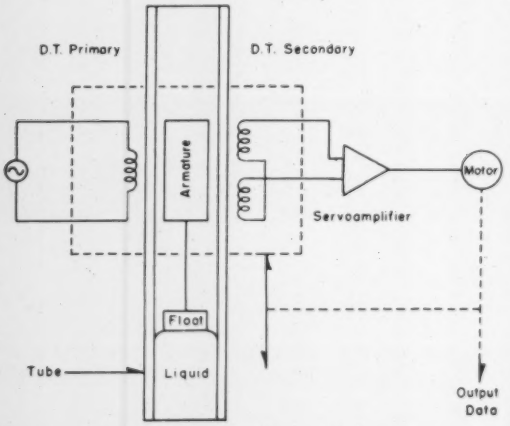
ACCO
TRADE MARK

For more information circle **124** on inquiry card.

For this literature circle number on inquiry card.

Servomanometer

A differential transformer (DT) is continuously positioned by a servo to be electrically centered about a float containing magnetic material. A proportional shaft position in the servo transmission is then analogous to the position of the liquid column. The armature, a section of



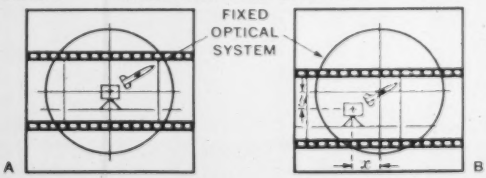
the float which is the magnetic portion, is located above or below the meniscus so as to leave the meniscus exposed. . . Exactel Servomanometers have been built which have a sensitivity of 1 micron. Another Exactel Servomanometer has a theoretical accuracy of better than 0.01 of reading, 144,000 scale units, and is believed to be the most accurate primary standard in existence. Another operates as a precision flowmeter in steam lines with line pressures as high as 6,000 psi. Others are used in what are believed to be the most accurate wind-tunnel Machmeters yet built. New construction practices make it possible to build the instruments in great ranges that have heretofore been impractical. . . (*From new* 8-*page Bulletin* 500, *Exactel Instrument Co.*, 5545 *Eva Ave., Los Altos, Calif.*)

For this literature circle **401** on inquiry card.

Powered Comparator

The image on the film is projected on the viewing screen with proper magnification selected by the operator. The operator measures the X and Y offsets of a target from

FIGURE 1 SCREEN WITH FIXED CROSSHAIRS



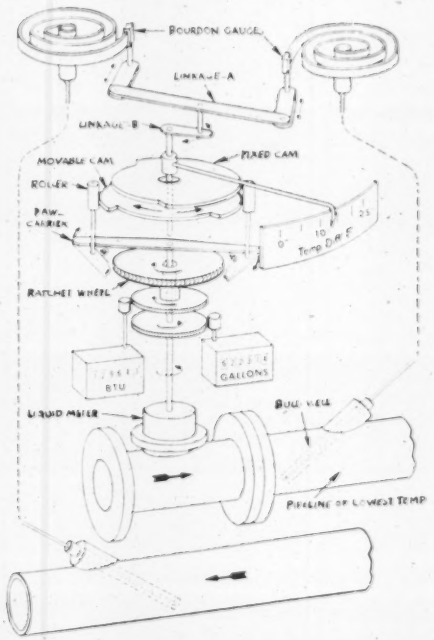
an established point by power-traversing the film. . . The attitude of the image, relative to the crosshairs, is determined by the angle through which the rotating table must be displaced in order to bring the crosshair and image into coincidence.

In the Coleman Powered Comparator, the target image is projected onto the fixed crosshairs of the screen, and the distance between the target and the reference point is determined by measuring the amount of film displacement required to cause the reference point to be projected to the same fixed crosshairs. . . (*From new* 4-*page Bulletin CR*-191, *Coleman Engrg. Co.*, 6040 *W. Jefferson Blvd., Los Angeles* 16, *Calif.*)

For this literature circle **402** on inquiry card.

BTU Meter

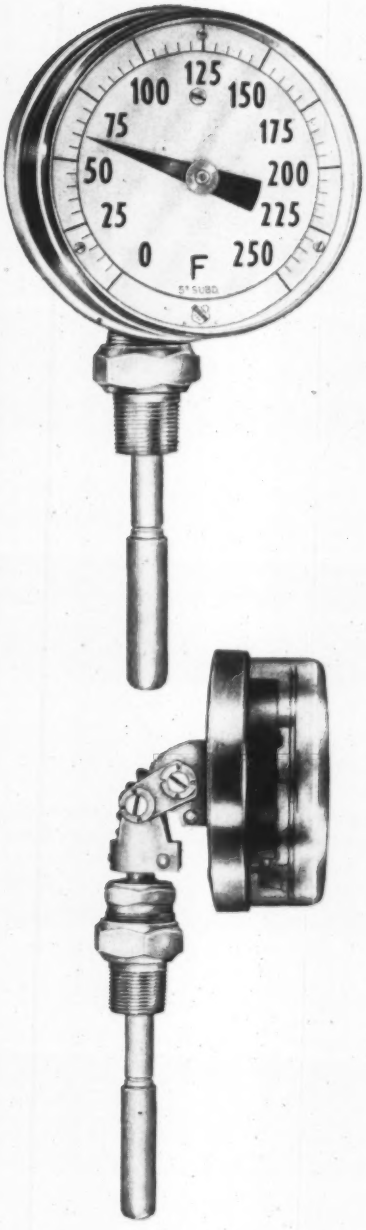
The Pollux BTU Integrating Meter measures the heat absorbed by a liquid, or the heat removed from the liquid. . . . The BTU Meter consists of a liquid meter, the integrating mechanism mounted on the liquid meter, two



wells which are inserted in the supply and return lines, and two temperature-sensitive bulbs filled with mercury which are inserted into wells. . .

The thermal expansion of the mercury in the two temperature-sensitive bulbs produces corresponding deflections of the Bourdon gage movements. . . The mechanism . . . continuously forms the product of temperature difference and liquid flow. The product gives the heat removed or added to the liquid circulating system. . . (*From new* 4-*page Bulletin* 1000, *Air Conditioning Equipment Corp., U. S. Distributors*, 219 *East* 44*th St., New York* 17, *N. Y.*)

For this literature circle **403** on inquiry card.



NEW

MERCURY ACTUATION

IN A MODERN 'AMERICAN' "Every Angle" DIAL THERMOMETER

If you expect the most for your money in readability, accuracy and durability, here is the best dial thermometer investment you can make. The 'American' Mercury-Actuated "Every Angle" Dial Thermometer provides a combination of five major advantages found in no other thermometer:

"Every Angle" Set-ability. You can turn the dial to any angle within 180° on two axes. Whether installed above or below eye level – to the right or left of the reading point – you get easy face-to-face readings.

Fast, Accurate Indication. Mercury – one of the most sensitive heat transfer mediums – makes possible readings up to 1000° F. in a few moments with accuracy within 1% of the entire scale range.

Surest, Sharpest, Easiest Readings. The Maxivision® dial – a split-level dial – is constructed so that the graduations and pointer are on the same plane. No perspective effect. No parallax error in reading.

Best in Visibility. The cover is a large, durable, clear glass dome without bezel. No dark shadows dim the dial to hinder reading accuracy.

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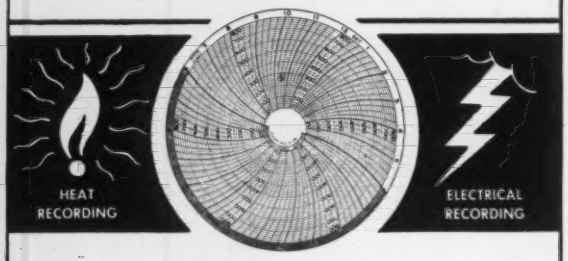

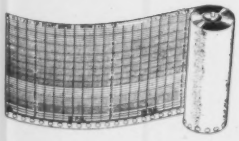

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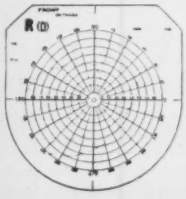

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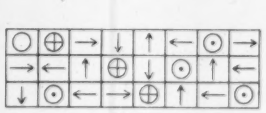
Briefs—CONTINUED

Permanent Magnets

According to the domain theory of ferromagnetism, a magnetic material is composed of elementary magnetic volumes called domains. These domains are randomly oriented in unmagnetized materials (Fig. 1). Their fields cancel each other, and no external field results.



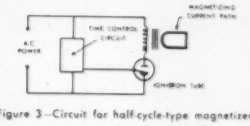
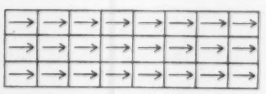


Figure 3—Circuit for half-cycle-type magnetizer



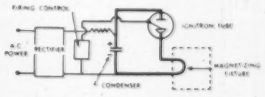


Figure 4—Circuit for energy-storage-type magnetizer

Subjecting the magnetic material to an external field rotates the elementary magnets in the direction of the applied field (Fig. 2). In permanent magnets; this orientation is retained to some extent after the field is removed. The magnetic material exhibits poles and an external field. . . . The main advantages of impulse-type magnetizers are lower equipment cost, reduced demand on power supply, and greater flexibility in shapes of fields that can be set up. Impulse equipment generally falls into two basic types: (1) Half-cycle type, operating from A. C. line (Fig. 3). Here, an ignitron tube with suitable control allows current to flow for one-half cycle. (2) Energy-storage type (Fig. 4). Here, a capacitor is charged at a relatively slow rate, and then discharged into the magnetizing circuit. This type of equipment is extremely versatile; tremendous peak currents are possible from

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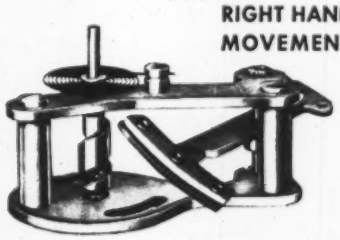
low-capacity power systems. (*From new 12-page Booklet "Trends and Developments for Electrical Design Engineers", General Electric; Metallurgical Products Dept., Detroit 32, Mich.*)

For this literature circle **404** on inquiry card.

Helicoid Gage

The Helicoid movement is as positive as helical gearing although its function is not to transmit power but merely to translate linear motion into rotary motion.

The surface of the roller groove is a helicoid. A helicoid is a surface generated by a straight line, one end of which

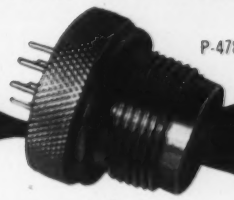


moves along an axis while the other end describes a spiral about it. The cam facing contacts this helicoid surface. Hence the name Helicoid movement.

To determine the wear characteristics of the Helicoid movement, the U. S. Testing Co., ran a test on two Helicoid Gages by mechanically pulsating the movement 1200 times a minute . . . After 75,000,000 cycles, the two Helicoid Gage movements showed no appreciable wear on the cam or roller. Gages with spur gear movements of stainless steel were identically tested at the same time. . . After only 500,000 cycles of operation, the gage pointer would not return to zero, and the gage was useless. . . (*From new 28-page Catalog G-52, Containing also pressure conversion table. Helicoid Gage Div., American Chain and Cable Co., 929 Connecticut Ave., Bridgeport 2, Conn.*)

For this literature circle **405** on inquiry card.

miniature SCHAEVITZ pressure transducer



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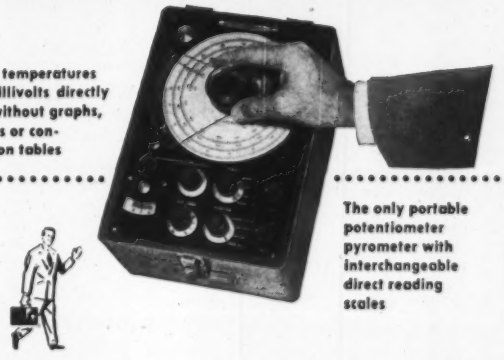

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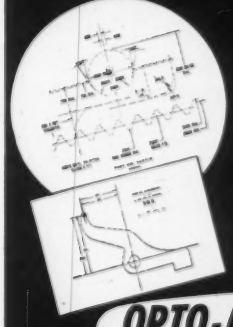

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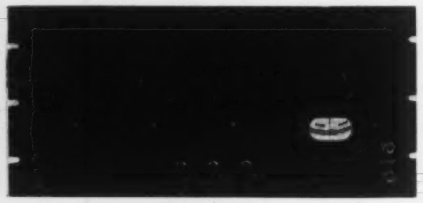

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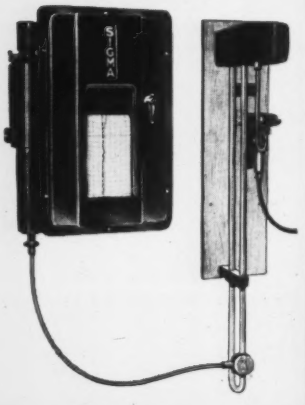

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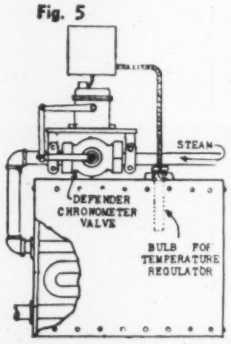
Fig. 5



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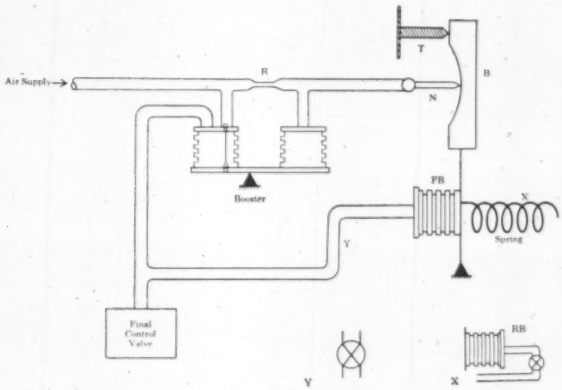

infrared or thermal conductivity gas analyzer, thermal converter, tachometer, load or pressure cells, the circuit is a d-c null-balance potentiometer. For measurements with the Thermohm (resistance thermometer) detector or electrolytic conductivity cell, the circuit is a d-c or a-c Wheatstone bridge. For measurements with a magnetic O_2 analyzer, the circuit is an a-c ratio bridge. The pneumatic system consists of a pilot assembly, gear-driven from the slidewire shaft, and booster for controlling air supply to final control device . . . (*From new* 12-*page Folder ND4* (9), *Leeds & Northrup Co.*, 4907 *Stenton Ave., Phila.* 44, *Pa.*)

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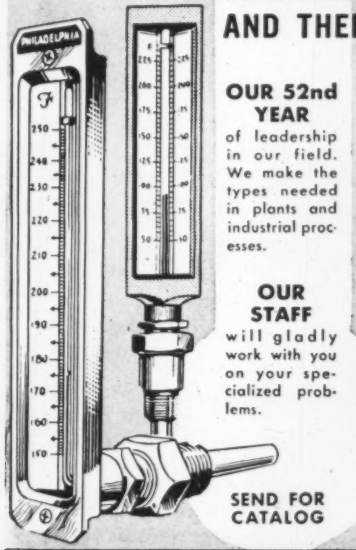

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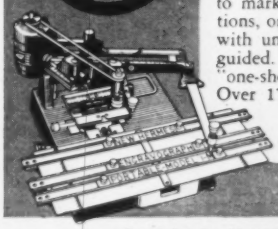

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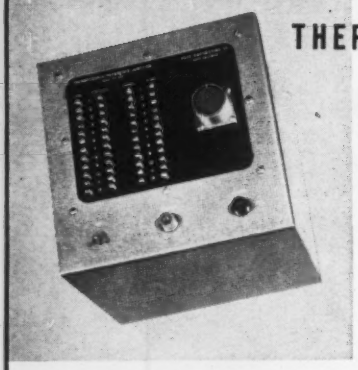

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Briefs—CONTINUED

Electrosyn System

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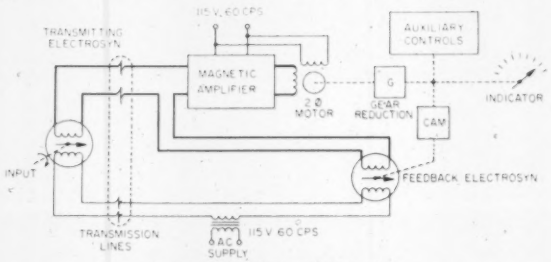

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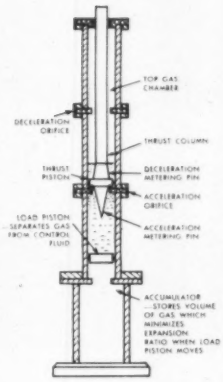
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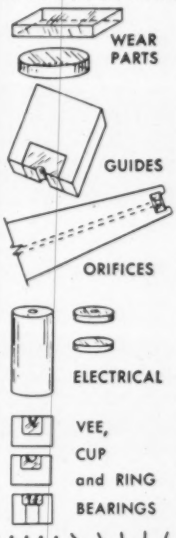

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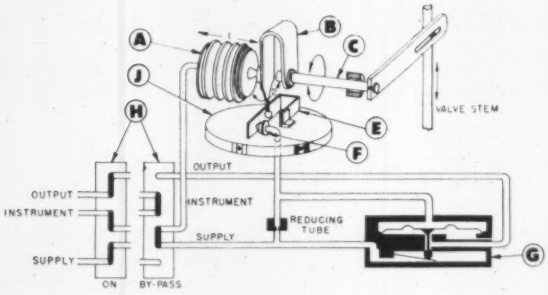

assembly away from flapper (E), which in turn covers nozzle (F). As pressure on the diaphragm of the control relay (G) increases, the relay valve closes the exhaust port, opens the supply port, and full supply pressure (20 psi) passes to the Valvactor output. . . With changes in controller output or process conditions, the valve plug is continuously repositioned to restore process stability, and the Valvactor returns to a balanced state. . . (*From new 8-page Bulletin* 5C-21, *The Foxboro Company, Foxboro, Mass.*)

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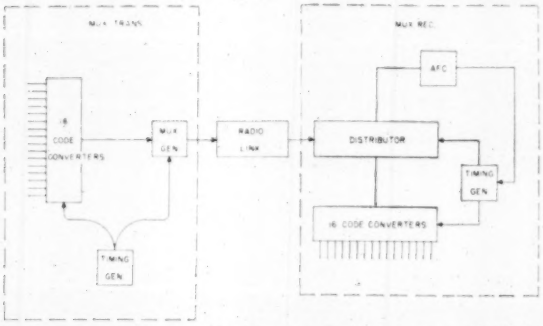

plex Transmitter and Receiver connected by a radio link. A single binary connection, via the radio equipment, must carry the necessary multiplex intelligence as well as all synchronizing information. The multiplex equipment receives input intelligence at teletypewriter speed already in binary form on each of its sixteen channels, and must compress the input signals with respect to time so that the message content of all sixteen inputs may be simultaneously passed over a single circuit. The binary digits (bits) in the multiplexed signal are transmitted at approximately 16 times the teletypewriter (TTY) speed . . . (*From new 12-page Bulletin "A Sixteen Channel Teletypewriter Terminal System," Rixon Electronics Inc., 2414 Reedie Dr., Silver Spring, Md.*)

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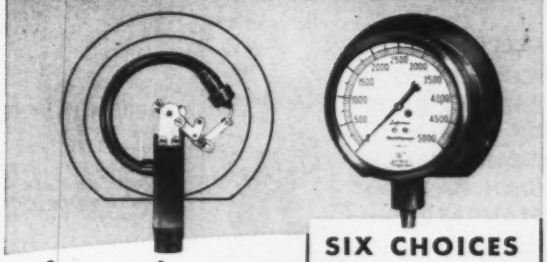

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For more information circle **148** on inquiry card.

INSTRUMENTS and AUTOMATION

New Literature

AUTOMATION

PROCESS INSTRUMENTATION is dealt with in 4-page Bulletin P 1271 on Dynamaster Series 663 indicators and recorders.—The Bristol Co., Waterbury 20, Conn.

Circle **413** on inquiry card.

POWER PLANT AND PROCESS control instruments introduced within the last year are fully covered in 8-page Bulletin G15-1 giving applications, ranges, and detailed literature references.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

Circle **414** on inquiry card.

HYDRAULIC ACCUMUATORS. 36-page Catalog 1530 covers new piston-type models from 10 cu-in to 10-gal oil capacity.—Industrial Hydraulics Div., The Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

Circle **415** on inquiry card.

PROCESS CONTROL. 8-page brochure describes Model 112 data processing system for process control.—Systems Div., Beckman Instruments, Inc., 325 Muller Ave., Anaheim, Calif.

Circle **416** on inquiry card.

BOILER CONTROL. Bulletin No. 1032 describes application of automatic control systems to large central station boilers, explains operation of the combustion, feedwater, feedpump and soot-blowing control systems.—Copes-Vulcan Div., Blaw-Knox Co., Erie, Penna.

Circle **417** on inquiry card.

HYDRAULIC POWER UNITS. Four-page bulletin describes Model 100 Air Hydraulic Unit and Model 200 Electric Hydraulic Unit, both capable of sustained pressures to 3000 psi.—Hi-Shear Rivet Tool Co., 2600 W. 247th St., Torrance, Calif.

Circle **418** on inquiry card.

PHOTOELECTRIC CONTROLS are described in 2-page data sheet.—Mason Instrument Co., 29 Elm Ave., Mt. Vernon, N. Y.

Circle **419** on inquiry card.

MOTORS

INCREMENTAL MOTOR is described in 2-page bulletin on the Stepper Motor, a bidirectional motor translating electrical pulses into uniformly accurate, rotary incremental shaft displacements.—Stepper Motors Corp., 7444 W. Wilson Ave., Chicago 31, Ill.

Circle **420** on inquiry card.

SHADED-POLE MOTORS. Four-page bulletin contains information on "402 Long Life" series with new "Camel Bearing," and "401 Standard Life" series.—Controls Co. of America, 9555 Soreng Ave., Shiller Pk., Ill.

Circle **421** on inquiry card.

FHP MOTORS. Twelve-page Bulletin S lists and describes 265 standard stock reducer and nonreducer motors of various types and sizes.—Bodine Electric Co., 2254 W. Ohio St., Chicago 12, Ill.

Circle **422** on inquiry card.

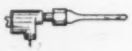
VALVES

SAUNDERS VALVES. Bulletin HB-6, 8 pages, gives construction details and operating characteristics of Series HB air-operated Saunders patent-types valves; includes sizing data and flow coefficients.—Conoflow Corp., 2100 Arch St., Phila. 3, Pa.

Circle **423** on inquiry card.

VALVES. Two-page "Section 11" describes maker's #811 hydraulic control pilot. Bulletin 56C features maker's representative valves.—Atlas Valve Co., 208 South St., Newark 5, N. J.

Circle **424** on inquiry card.



TEMPERATURE

MIDGET INDUSTRIAL THERMOMETERS are described in Bulletin M.I.T. 57—Weksler Thermometer Corp., 195 East Merrick Road, Freeport, L. I., N. Y.

Circle **425** on inquiry card.

FINNED TUBING EXCHANGERS and their comparative costs are described and discussed in 20-page booklet on "Design and Cost Comparison of Heat Exchangers . . . Using Wolverine Trufin."—Wolverine Tube, Div. of Calument & Hecla, Inc., Detroit, Mich.

Circle **426** on inquiry card.

THERMOSTATIC BIMETALS. "The Story of the Spencer Disc," 2nd edition, is a 32-page booklet on the Spencer Disc, how it actuates Klixon thermostats, circuit breakers, motor protectors, etc.—Spencer Thermostat Div., of Metals & Controls Corp., Attleboro, Mass.

Circle **427** on inquiry card.

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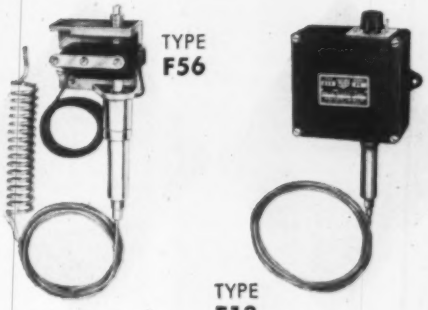

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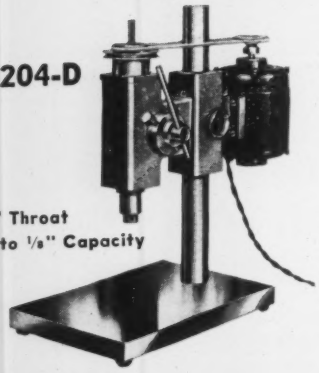

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For more information circle **153** on inquiry card.

NEW LITERATURE

THERMOSTATS. Two-page Bulletin 4000 describes maker's line of Type W bimetal strip thermostats for use in fans, electronic and avionic devices, etc.—Stevens Mfg. Co., Inc., 45 N. Plymouth St., Lexington, Ohio.

Circle **428** on inquiry card.

THERMISTORS. Four-page pamphlet V 270 shows how high negative temperature coefficient of thermistors can be used to advantage.—Victory Engineering Corp., Springfield Road, Union, N. J.

Circle **429** on inquiry card.

FLOW, PUMPS

FLOW-RATE TRANSMITTER. Eight-page Bulletin MSP-136 describes High Pressure Type Flow Signal Transmitter utilizing force-balance principle to convert differential into pneumatic signal requiring no additional devices for square-root extraction.—Hagan Chemicals and Controls, Inc., Hagan Bldg., Pittsburgh 30, Pa.

Circle **430** on inquiry card.

ROTAMETERS. Twelve-page Bulletin 115 describes "Full-View" rotameters with new metering float.—New low-cost "Sho-Rate 150" rotameter with 150-mm scale length is described in 2-page Bulletin 121.—Brooks Rotameter Co., Lansdale, Penna.

Circle **431** on inquiry card.

FLOW RATE CONTROLLER for backwash of water softeners is described and illustrated in new 4-page Bulletin 237.—Industrial Sales Div., Hays Mfg. Co., Erie, Pa.

Circle **432** on inquiry card.

METERING PUMPS. Four-page Data Sheet, D-57-1 describes methods of combating corrosion and deligrification in cooling towers, using controlled-volume pumps to meter precise quantities of chemical to cooling water.—Milton Roy Co., 1300 E. Mermaid Lane, Phila. 18, Pa.

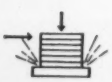
Circle **433** on inquiry card.

MASS FLOWMETER. Four-page bulletin describes new Type FM100 of the Laub Electro-Caloric Flowmeter; which was specially designed for measuring mass flow rates of fluids in laminar flow.—Industrial Development Labs., Inc., Jersey City, N. J.

Circle **434** on inquiry card.

SEALLESS PUMPS. 8-page catalog describes "Flex-i-liner" sealless plastic and stainless steel pumps suitable for over 120 chemical solutions. —Vanton Pump & Equipment Corp., Hillside, N. J.

Circle **435** on inquiry card.



PRESSURE, WEIGHT

PRESSURE INSTRUMENTS. Two-page Bulletin 1586 describes applications and operations of maker's High-Speed

Electromanometer. Two-page Bulletin 1581 describes Type 6-201 Primary Pressure Standard.—Consolidated Electrodynamics Corp., 300 North Sierra Madre Villa, Pasadena, Calif.
Circle **436** on inquiry card.

PRESSURE AND DRAFT GAGES. Eight-page Bulletin MSP-134 describes the three types and many styles of MP Indicators.—Hagan Chemicals & Controls, Inc., Hagan Bldg., Pittsburgh 30, Pa.
Circle **437** on inquiry card.

PRESSURE PICKUPS. Six 2-page specification sheets cover models for measurement of absolute pressure, acceleration, etc.—Statham Laboratories, Inc., 12401 West Olympic Blvd., Los Angeles 64, Calif.
Circle **438** on inquiry card.

PRESSURE PICKUP. Four page brochure describes SLM DPI-114 Differential Pressure Indicator.—Kistler Instrument Corp., 15 Webster St., North Tonawanda, N. Y.
Circle **439** on inquiry card.

TWO REYERS BALANCES. "Progress" for analytical laboratory weighing and "Rapid" for bulk weighing and dispensing, are described and illustrated in a 2-page data sheet.—Arthur S. LaPine & Co., 6001 South Knox Ave., Chicago 29, Ill.
Circle **440** on inquiry card.

TIME, COUNT

PREDETERMINING COUNTER. Two-page bulletin describes new electric predetermining counter with automatic reset having five decade knobs.—Electronic Control Div., Veeder-Root Inc., Hartford 2, Conn.
Circle **441** on inquiry card.

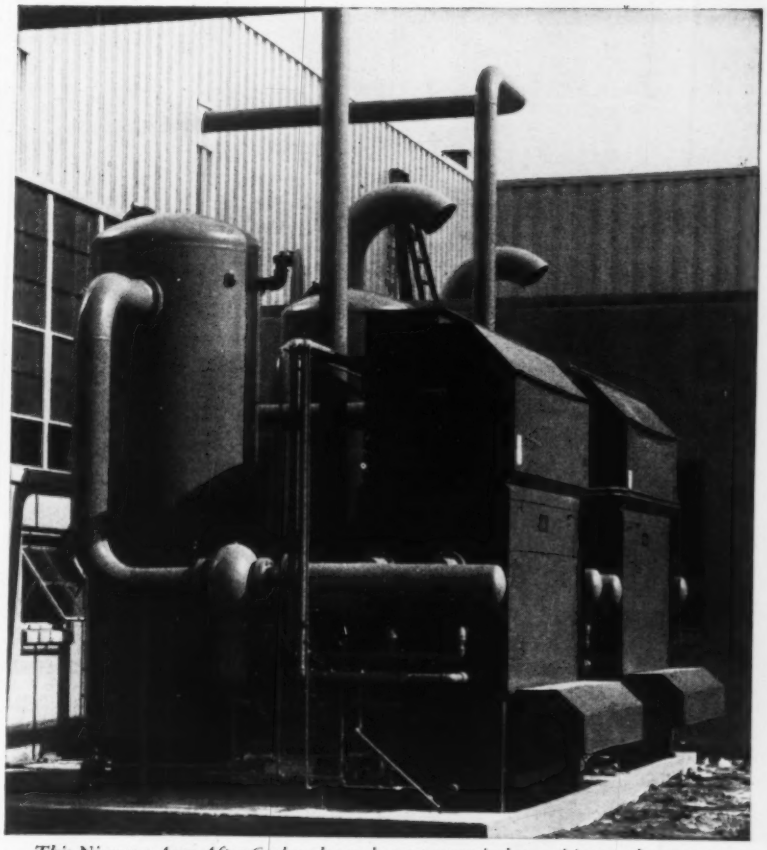
ELECTRICAL STOP CLOCK is subject of 4-page Bulletin No. PB-691.—Cramer Controls Corp., Centerbrook, Conn.
Circle **442** on inquiry card.

COUNTING INSTRUMENTS. Four-page Catalog AD 330 presents heavy-duty electric, stroke and revolution counters.—Production Instruments Div., General Controls Co., 702 W. Jackson Blvd., Chicago 6, Ill.
Circle **443** on inquiry card.

TIMING MOTORS. Four-page bulletin describes new line of high-torque synchronous timing motors of permanent magnet and hysteresis types.—The E. Ingraham Co., Bristol, Conn.
Circle **444** on inquiry card.

SUBMINIATURE TIMER. Four-page brochure describes new small timer (1½" square, weighing 6 oz) hermetically sealed.—The Advanced Products Co., 59 Broadway, North Haven, Conn.
Circle **445** on inquiry card.

REPEAT-CYCLE TIMERS, available in 4 models with on and off intervals from 0.01 to 1000 seconds and various relays, are described in 4-page leaflet, including wiring diagrams.—G. C. Wilson & Co., Huntington, W. Va.
Circle **446** on inquiry card.



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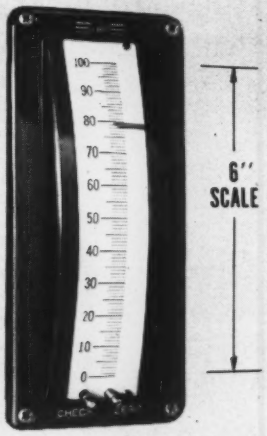
If your variable can be detected in terms of linear change in position, this system will provide a low-cost indication of that variable. OEM's please note!



TEMPERATURE • PRESSURE • LEVEL • WEIGHT • DISPLACEMENT DIMENSION • POSITION • ETC.

COMPLETE SYSTEM

Atcotran Indicator System consists of a differential transformer (± 0.15" motion) transmitter which sends an a-c signal proportional to change in the measured media and a "linear motor" which drives the pointer. The null-balance circuit is not critically affected by normal line voltage fluctuations.

ACCURATE

Atcotran vertical scale indicators are readable to ½ per cent. Linearity is ± ½ per cent and repeatability is better than ± ¼ per cent.

DEPENDABLE

This instrument utilizes the ATC performance proven amplifier circuit. Its electronic components are very conservatively rated and will provide long trouble-free operation without servicing.

VERSATILE

The wide variety of quantities measured by Atcotran Indicator Systems permits a high degree of standardization. 0-100 scale is standard, special scales are supplied on order. Unit plugs into 115 volt, 60 cycle outlet. ILLUMINATED SCALE. Designed especially for panel board mounting. An excellent tool for "Graphic Panel" applications, Test Cells, Process Control Systems, etc.

LOW COST

First unit is well under $200. Quantity orders permit substantial reductions.

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AUTOMATIC CONTROL SYSTEMS & COMPONENTS

AUTOMATIC TIMING & CONTROLS, INC.
formerly Automatic Temperature Control Co., Inc.
Subsidiary of Safety Industries, Inc.
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FOREIGN SALES: ATC EXPORT DEPARTMENT, 1505 RACE ST., PHILA 2, PA.

For more information circle **155** on inquiry card.

NEW LITERATURE

PROGRAM TIMER. Two-page Bulletin 506 describes "Programonitor" recycling, circuit-controlling counter, which responds to variable-speed mechanical or electrical inputs, or with constant-speed mechanical or electrical inputs, or with constant-speed drive serves as a timer.—Counter and Control Corp., 5225 W. Electric Ave., Milwaukee 19, Wis.

Circle **447** on inquiry card.

ANALYTICAL

CHEMICAL ANALYSIS. New "Package #4-1" of literature covers four separate reports on: fluorescence spectrophotometry; near infrared spectrophometry; analysis of aerosol-type propellents by gas chromatography; and a recording spectrophotometer application.—Beckman/Scientific Instruments Div., Fullerton, Calif.

Circle **448** on inquiry card.

PROCESS CHROMATOGRAPH. Seven-sheet Bulletin 1836A describes Type 26-202 process chromatograph for remote control and recording.—Consolidated Electrodynamics, 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle **449** on inquiry card.

pH BUFFER KIT. Four-page brochure contains instructions for use of analytical pH buffer kit.—Analytical Measurements, Inc., 585 Main St., Chatham, N. J.

Circle **450** on inquiry card.

COMBUSTIBLE GAS DETECTOR, capable of handling any type of hydrocarbon including that given off by the latest jet engine fuels, is described in 4-page leaflet.—Hunter-Bristol Corp., Bristol, Penna.

Circle **451** on inquiry card.

pH METER. 2-page Bulletin 195 describes line-operated pH meter Model 85 whose 3" scale covers complete pH range from 0 to 14, and can easily be read to an accuracy of 0.1 pH.—Photovolt Corp., 95 Madison Ave., New York 16, N. Y.

Circle **452** on inquiry card.

HUMIDITY

HUMIDITY MONITOR. Four-page leaflet describes Type 26-310 Process Moisture Monitor for continuous humidity measurement (to lppm) of process streams, with remote recording and automatic control.—Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle **453** on inquiry card.

DEHYDRATORS. Two-page Bulletin 302 describes three new models of Dehydrafilters, desiccant dehydrators used to dry air lines to controls and instruments.—Hankison Corp., 951 Banksville Road, Pittsburgh 16, Pa.

Circle **454** on inquiry card.

LABORATORY

LABORATORY EQUIPMENT is the subjects of three new releases: "Vaportemp" low cost relative humidity chamber and "Counter-flow" controlled relative humidity cabinets are described in new 4-page Bulletin 5525-A; electric ovens and furnaces are presented in 4-page Bulletin 5520-A; variable speed mixers and motors are contained in 6-page Bulletin 1540.—Gardner Laboratory, Inc., Box 5728, Bethesda 14, Md.

Circle **455** on inquiry card.

LABORATORY EQUIPMENT. Latest 16-page issue of "Lab Log" describes electrobalance, photomicrography illuminator, ac line-operated spectrophotometer, freeze-dry equipment, Stabiltherm utility oven and a multi-purpose constant temperature bath.—Will Corp., Rochester 3, N. Y.

Circle **456** on inquiry card.

FUME HOODS and accessories used in industrial, educational, and hospital laboratories are described in 2-page data sheet.—Arthur S. LaPine & Co., 6001 South Knox Ave., Chicago 29, Ill.

Circle **457** on inquiry card.

LABORATORY BALANCES. Pamphlet CB37 on new two-pan Projecta Analytical Projection Balance; announcement of Sartorius Projection Balances; Catalog Supplement Sheets 13/14 on Sartorius Speed Balances; announcement of Sartorius Microtar torsion balance are four new 2-page bulletins. Also available: 4-page condensed catalog of Ipscaphot and Microphot exposure meters; and 4-page Catalog Section C on low-power micromanipulators.—Brinkman Instruments, Inc., Great Neck, L. I., N. Y.

Circle **458** on inquiry card.

NUCLEONICS

POWER REACTOR SYSTEMS. 28-page Bulletin GER-1384 reviews reactor systems to produce commercially useful electricity from nuclear energy.—Apparatus Sales Div. General Electric Co., Schenectady 5, N. Y.

Circle **459** on inquiry card.

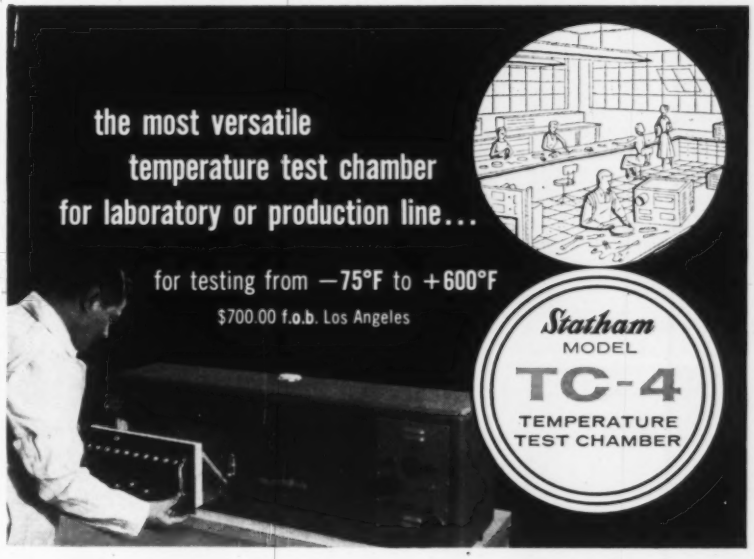
CONTAMINATION MONITOR. Catalog sheet illustrates and gives applications, operational details and specs on Model LM 48 Lab Monitor.—Radiation Instrument Development Lab. (RIDL), 5737 S. Halsted St., Chicago 21, Ill.

Circle **460** on inquiry card.

OPTICAL

OPTIC TOOLING is treated in 56-page manual showing the optical principles used in applying maker's equipment.—Keuffell & Esser Co., Hoboken, N. J.

Circle **461** on inquiry card.



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DEVELOPMENT CORPORATION
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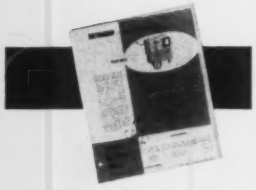
MOBILE AIR PARTICLE MONITOR

AEC acceptance . . . completely self-contained . . . mounted on pneumatic tires for rapid portability . . . eliminates duplication of radiation detection equipment—that's just *part* of the story on Victoreen's Model 900-2 Mobile Constant Air Particle Monitor.

Other important features are a new rate meter design that covers five decade range on a single scale . . . logarithmic count rate meter eliminates electro-mechanical switching . . . new constant speed pump motor design . . . simple valve adjustment controls flow rate . . . built-in alarm warning system . . . fail-safe design.



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NEW LITERATURE

INTERFERENCE FILTERS. Bulletin 302UV and price list of Schott-Jena Monochromatic Interference Filters for ultraviolet spectral region.—Fish-Schurman Corp., 70 Portman Road, New Rochelle, N. Y.

Circle **462** on inquiry card.

DATA HANDLING

AN-DIG & DIG-AN CONVERTER. Two-page bulletin announces new "Multiverter" fully transistorized conversion system operating with better than 0.01% accuracy and generating either a product or a quotient.—Packard-Bell Computer Corp., 11766 W. Pico Blvd. Los Angeles 64, Calif.

Circle **463** on inquiry card.

DIGITIZING DEVICE. Two-page bulletin describes "Model SL-1004 Servo Digitizer" which positions a binary-decimal encoder from a 400-cps input signal.—Industrial Control Co., Wyandanch, L. I., N. Y.

Circle **464** on inquiry card.

MAGNETIC RECORDING TAPES used under abnormal or extreme conditions are discussed in new 3-page Bulletin 35.—Minnesota Mining and Mfg. Co., Dept. M7-218, St. Paul, Minn.

Circle **465** on inquiry card.

DIGITAL INSTRUMENTS, voltmeters, ohmmeters, ratiometers, etc., and their accessories are described in 28-page 1957 Interim Catalog and in three 2-page specification sheets.—Non-Linear Systems, San Diego County Airport, Del Mar, Calif.

Circle **466** on inquiry card.

COMPUTING SYSTEMS with great programming versatility, high operating speed and large storage capacity is described in 12-page brochure on Univac Scientific Model 1103A.—Remington Rand Univac, Div. of Sperry Rand Corp., 1902 W. Minnehaha Ave., St. Paul W4, Minn.

Circle **467** on inquiry card.

ENCODER. Two-page leaflet describes "Oread" optical rotational encoder for converting analog data to decimal form. Electronic Instruments including waveform and pulse generators microwave power measuring equipment, test set, power supply, etc., are briefly described in 4-page brochure.—Cubic Corp., 5575 Kearny Villa Rd., San Diego 11, Calif.

Circle **468** on inquiry card.

IN-LINE DIGITAL DISPLAY, made up of individual units 1½" wide providing a one-place presentation, is described in 2-page Bulletin ILD-1.—Industrial Electronic Engineers, 3973 Lankershim Blvd., North Hollywood, Calif.

Circle **469** on inquiry card.

PIPE, TUBING, FITTINGS

PVC PIPE FITTINGS AND FLANGES. 24-page booklet gives data on unplasticized polyvinyl chloride pipe,

also complete specs for threaded and socket types of PVC fittings, valves and flanges.—Tube Turns Plastics, Inc., 2929 Magazine St., Louisville 11, Ky.

Circle **470** on inquiry card.

REINFORCED PVC TUBING ("Bardex"), which resists gasoline, sea water, etc. and stays flexible between −5°F and 170°F, is described in two-page leaflet.—Newage International Inc., 222 York St., Jenkintown, Penna.

Circle **471** on inquiry card.

TUBING in all sizes, in many metals and alloys, is described in 12-page catalog—"Wolverine Serves the Refrigeration Industry".—Wolverine Tube, Div. of Calument & Hecla, Inc., Dept. TR-Guardian Towers, Guardian Bldg., Detroit 26, Mich.

Circle **472** on inquiry card.

PVC PIPE. Twelve-page Bulletin A557 describes maker's regular and high-impact corrosion-resistant rigid polyvinyl chloride pipe.—Alpha Plastics Inc., 78 Okner Parkway, Livingston, N. J.

Circle **473** on inquiry card.

PROTECTIVE CLOSURES are described and illustrated in new 4-page Catalog No. 57-4 on Shurclose Caps and Plugs.—Shurclose Seal Co., 3000 East Grand Blvd., Detroit 2, Mich.

Circle **474** on inquiry card.

POLYAMIDE TUBING. 4-page Bulletin BR-3A describes characteristics and installation of new flexible polyamide tubing ("Nylaflow") along with available sizes.—The Polymer Corp. of Pa., 2140 Fairmont Ave., Reading, Pa.

Circle **475** on inquiry card.

RECORDERS

DENSITOMETER-RECORDER for paper electrophoresis. New "Varicord" variable-response recorder is described and discussed in 16-page bulletin.—Photovolt Corp., 95 Madison Ave., New York, 16, N. Y.

Circle **476** on inquiry card.

MAGNETIC TAPE RECORDERS. Folder contains 16-page booklet on Magnetic Tape Instrumentation and six lesser pieces of literature.—Instrumentation Div., Ampex Corp., Redwood City, Calif.

Circle **477** on inquiry card.

TESTING

CURRENT DRIVERS. New types 3003 and 3004, for testing square-loop tape-wound bobbin cores, are described in 4-page brochure with specs including rise time, duration, and amplitude of rectangular output current pulse.—Burroughs Corp., Electronic Insts., Div., 1209 Vine St., Phila. 7, Pa.

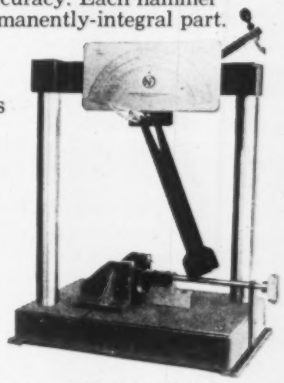
Circle **478** on inquiry card.

PINHOLE DETECTOR. Four-page Bulletin 6520A describes redesigned pinhole detector.—General Electric, Schnectady 5, N. Y.

Circle **479** on inquiry card.

impact tester

The machine that makes the Izod (cantilever beam) or Charpy (simple beam) test on each of three capacity ranges. Separate hammer for each test in each capacity range (6 hammers in all). Hammers are interchangeable. Individual calibration of each hammer assures accuracy. Each hammer is one welded unit striking bit—a permanently-integral part. Possibility of variable errors due to energy absorption by screwed-on weights and detachable bits is eliminated. Attachment of hammers is at point of suspension minimizing any effect of looseness.



FEATURES:

- Three energy scales:
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- Individually calibrated hammers—no separate weights
- Long, open linear energy scales
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INDUSTRIAL, AIRCRAFT and MILITARY applications

75[illegible] Series DC Elapsed Ti[illegible] Indicator. Send for Bulletins: AWH ET600. Basic Elapsed Time Indicators 7500, 12500, 24200 Series.

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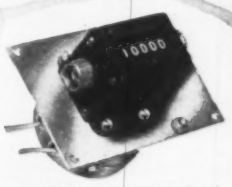

7500 Series Reset Type Elapsed Time Indicator. Send for Bulletins: AWH ET601. Reset Type Elapsed Time Indicators 7500, 12500, 24200 Series.

Now the Company offers a complete line of timing motors and devices to record the operating time of any electrical or electronic equipment. Compact, minimum weight, each unit has five digits. They can be used to provide daily running time plus a total running record, eliminating estimating or manual totalizing. In both AC and DC, continuous or manual reset for 50 or 60 up to 400 cycle line frequency. Will measure hours or on down to 10ths of seconds. All models can be supplied with Radio Interference Filtering, to meet MIL-1-6181B.

Shown at the left is the new A. W. Haydon Co. catalog describing the complete line of timing motors and devices; if you haven't received your copy write for it on your company letterhead.

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Design and Manufacture of Electro-Mechanical Timing Devices

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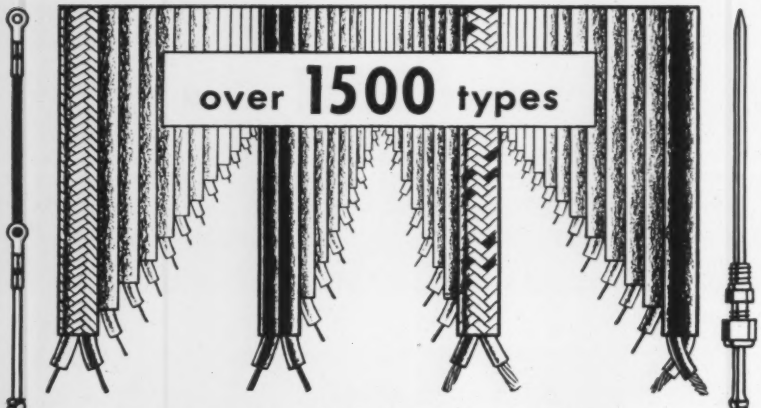

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Thermo Electric makes and stocks a countless variety of thermocouple and extension wires, both solid and stranded conductors—for *any* application, for *all* conditions. In fact, on T-E's shelves are over 1500 *different* wire combinations of advanced insulations, all standard calibrations, and gage sizes from 11-40—the widest selection known. Metallic armor overbraids of many hi-temp materials provide extra mechanical protection and electrical shielding. Whatever you need, in wire or multi-conductor cables, T-E has it. Prompt delivery.

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TANK MAY BE BURIED, ELEVATED, OPEN, CLOSED, VENTED OR UNDER PRESSURE OR VACUUM

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NEW LITERATURE

CURRENT DRIVERS. New Types 3003 and 3004, for testing square-loop tape-wound bobbin cores, are described in 4-page brochure with specs including rise time, duration, and amplitude of rectangular output current pulse.—Burroughs Corp., Electronic Instruments Div., 1209 Vine St., Philadelphia 7, Pa.

Circle **480** on inquiry card.

POSITIONING UNIT. Bulletin SPU 164 describes Type 164 two-speed synchro positioning unit.—GAP Instrument Corp., 101 Albany Ave., Freeport, L. I., N. Y.

Circle **481** on inquiry card.

IR SAMPLING TECHNIQUE. Four-page technical data sheet IR-74-MI(T) explains potassium bromide sampling technique in infrared studies on solid substances.—Scientific Instruments Div., Beckman Instruments, Inc., Fullerton, Calif.

Circle **482** on inquiry card.

RELAY TEST INSTRUMENTS. Five-page Data Sheet #167 gives complete specifications, block diagrams and photographs of new line of relay test instruments.—Multi-Amp Corp., 465 Lehigh Ave., P. O. Box 217, Union, N. J.

Circle **483** on inquiry card.

HYDRAULICS TEST MACHINE for components is described in 4-page Brochure HA-100.—Greer Hydraulics, Inc., N. Y. International Airport, Jamaica 30, N. Y.

Circle **484** on inquiry card.

GAGING

THICKNESS MEASUREMENT. Two bulletins, V-301 and V-302, discuss the uses of the "Vidigage," an ultrasonoc resonance instrument for quick and accurate detection of corrosion and laminar flaws, and for measuring metal or plastic thicknesses.—Branson Instruments, Inc., 40 Brown House Rd., Stamford, Conn.

Circle **485** on inquiry card.

THREADS. Sixteen-page booklet contains information about 3A threads.—Standard Pressed Steel Co., Jenkintown, Penna.

Circle **486** on inquiry card.

DIAL INDICATORS. Bulletin No. 557 describes recently developed "Golden Em-re" dial indicators.—Petz-Emery, Inc., Pleasant Valley, N. Y.

Circle **487** on inquiry card.

PIN GAGES. Eight-page pocket guide gives data on standard barrel, bar and indicator flush pin gages.—Union Gage Corp., 710 Lehigh Ave., Union, N. J.

Circle **488** on inquiry card.

ITV

ITV. Eight-page Quick Reference Catalog covers maker's complete line of industrial television cameras, monitors, mounts, controls and accessories.—Allen B. Du Mont Labs, Inc., 760 Bloomfield Ave., Clifton, N. J.

Circle **489** on inquiry card.

CLOSED CIRCUIT TV. Six-page Catalog 6-42 describes maker's wired closed-circuit ITV system comprising camera, camera control, and monitor.—Kin Tel Div., Cohu Electronics, Inc., 5725 Kearny Villa Road, San Diego 11, Calif.

Circle **490** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

STABILIZED D-C AMPLIFIERS. Two-page Data Sheet ED7(1) describes stabilized dc voltage-and-current-indicating amplifiers, with examples of applications for strain gages, thermocouples, phototubes, etc..—Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.

Circle **491** on inquiry card.

FREQUENCY MEASUREMENTS are described in 17-page Data File 111, covering low to UHF frequencies, also rotational velocity, flow pressure, temperature and strain with makers EPUT meters.—Beckman/Berkeley Div., Dept. 7250, 2200 Wright Ave., Richmond 3, Calif.

Circle **492** on inquiry card.

ELECTRONIC INSTRUMENTS. 4-page, July-1957 issue of *hp* Journal contains articles on the 0-120-kc frequency counter and on uses for the 650A test oscillator.—Hewlett-Packard Co., 275 Page Mill Rd., Palo Alto, Calif.

Circle **493** on inquiry card.

ELECTRONIC INSTRUMENTS. Four-page Catalog No. 17-1 describes dc amplifiers, microvoltmeters; a new electronic galvanometer; dc power supplies; dc meter calibrators, and a new dc standard and null meter.—KIN TEL Div., Cohu Electronics, Inc., 5725 Kearny Villa Rd., San Diego 11, Calif.

Circle **494** on inquiry card.

ELECTRONIC TEST INSTRUMENTS are described in 24-page Catalog B, including dc vacuum tube voltmeters, electrometers, meg-megohmeters, micro-micrommeters, etc.—Keithley Instruments, Inc., 12415 Euclid Ave., Cleveland 6, Ohio.

Circle **495** on inquiry card.

ELECTRONIC INSTRUMENTS. 8-page Catalog C-704 describes 20 new instruments added to line of digital and analog instrumentation.—Berkeley Div., Beckman Instruments, Inc., 2200 Wright Ave., Richmond 3, Calif.

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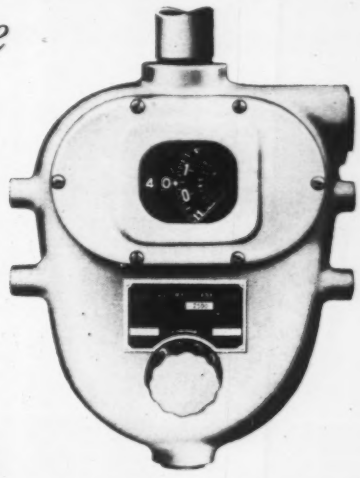

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Other Patents Pending

Seven solid years of proven service stand behind the "Varec" Fig. 2500 AUTOMATIC TANK GAUGE. It was first with the NEG'ATOR MOTOR – a feature so good that competition copies. It's not new it's been tested for seven years. Because it is a long-deflection constant force element it is *not* a spring – It is a motor!

When you have to squint into a look-box, even if the gauge tape is clean, you are subject to parallax – (if you are tall, you read the tape *low*; if you are short you read the tape *high* . . . that's parallax). A mis-reading of 1/8 inch can cost you or your customer many barrels of oil on a large tank. Accuracy is assured with the "Varec" Counter and Dial System (Patent claim allowed but not yet issued – other patents pending). Gravity Compensator adjustments made at counter assembly without exposure to tank vapor or pressure. Tank vapors sealed off from counter assembly. Removal of front cover plate will not de-pressure tank. Patented operation checker for testing gauge operation.

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Tell your "Varec" representative your gauging problem, our Engineering Department will come up with the correct answer. You will have a gauge that leads the field – that stands for quality and accuracy first and it will cut your "unaccountable losses." That's why the "Varec" Fig. 2500 has a fast "pay-out."

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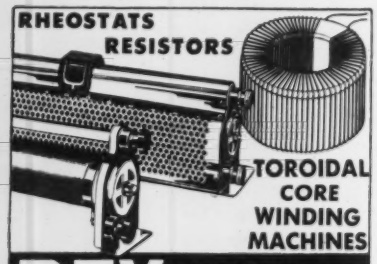

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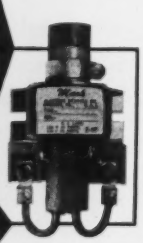

One moving part • silent • no exposed arc • U.L. listed • motor loads to 2 hp. • will switch 35 amp inductive load • available in various mountings

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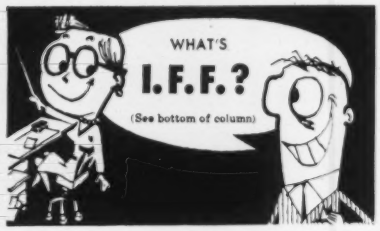

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NEW LITERATURE

PHASEMETER. Two-page bulletin describes recently-developed Model PM-1B "Phasemaster".—Statham Development Corp., 12411 West Olympic Blvd., Los Angeles 64, Calif.

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VARIABLE TRANSFORMER. Four-page Bulletin SE-L3578 gives illustrations and rating data on new double-wound Powerstat.—The Superior Electric Co., Dept LW, 83 Laurel St., Bristol, Conn.

Circle **498** on inquiry card.

TRANSISTOR EQUIPMENT. Ten-page folder covers transistorized products, including inverters and converters, power packs, test equipment, power supplies, packaged circuits, etc.—Electronic Research Assocs., 67 East Centre St., Nutley 10, N. J.

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GERMANIUM RECTIFIERS. 4-page Bulletin ER-110 describes new line of low-priced self-contained germanium rectifiers.—Hanson-Van Winkle-Munning Co., Church St., Matawan, N. J.

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PRIVATE-LINE CARRIER. 4-page bulletin describes Type PLC private line telephone carrier equipment for multi-party telephones.—Budelman Radio Corp., 375 Fairfield Ave., Stamford, Conn.

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MICROWAVE OSCILLATORS. Four-page leaflet describes maker's line of stable microwave oscillators, including new Model 815, which covers the frequency band of 9000 to 10,500 Mc. —Laboratory for Electronics, Inc., 75 Pitts St., Boston 14, Mass.

Circle **502** on inquiry card.

STANDARD FREQUENCY COMPARATOR. Two-page Bulletin 457 describes new Model SR-7 receiver for standard frequency comparisons.—Specific Products, P. O. Box 425 Woodland Hills, Calif.

Circle **503** on inquiry card.

DRY TYPE TRANSFORMERS which can handle up to 1000% inrush current with only a 5% voltage drop below rated capacity are described in 4-page Bulletin 300.—Hevi-Duty Electric Co., Milwaukee 1, Wis.

Circle **504** on inquiry card.

COMPUTING AMPLIFIERS. Two-page bulletin describes Series 5-1100 chopper-stabilized d-c amplifiers.—Dynalysis Development Labs., Inc., 11941 Wilshire Blvd., Los Angeles 25, Calif.

Circle **505** on inquiry card.

ELECTRONIC GAGE. Four-page Bulletin No. 1G-001 describes Versachek Electronic Gage, versatile in selection of ranges.—The Taft-Peirce Mfg. Co., Woonsocket, R. I.

Circle **506** on inquiry card.

MAGNETIC DEFLECTION YOKE. New 2-page leaflet provides data, and technical description of maker's new miniature epoxy-encapsulated push-pull magnetic reflection yoke.—Syntronic Instruments Inc., 170 Industrial Rd., Addison, Ill.

Circle **507** on inquiry card.

TRANSISTORS, TUBES

HIGH-TEMPERATURE TRANSISTORS. Four-page Vol. 1-No. 5 issue of "New Parameter News" is a condensed catalog of maker's silicon and germanium transistors.—Texas Instruments Inc., P. O. Box 312, Dallas, Texas.

Circle **508** on inquiry card.

SUBMINIATURE GLASS DIODES incorporating alloys of silicon and germanium are described in 2-page announcement.—Clevite Transistor Products Div. of Clevite Corp., 241 Crescent St., Waltham 54, Mass.

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MAGNETICS

PERMANENT MAGNETS. 12-page Bulletin RC-11A describes new "Ceramagnet" material with characteristic graphs; includes 2-page catalog and price list supplement.—Stackpole Carbon Co., St. Marys, Penna.

Circle **510** on inquiry card.

MAGNETIC SHIELDING CAN. 5-page Data Sheet 126 describes new 3-layer economical rotary drawn Netic Co-Netic magnetic shielding cans.—Magnetic Shield Div., Perfection Mica Co., 1322 No. Elston Ave., Chicago 22, Ill.

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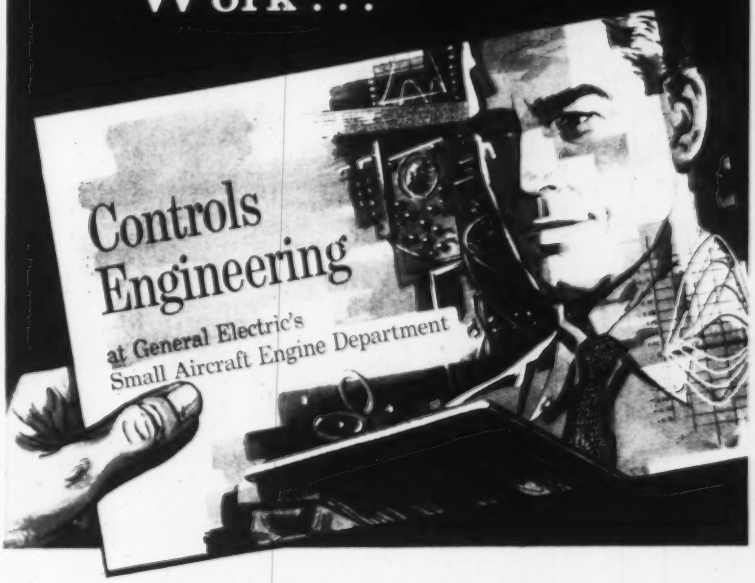

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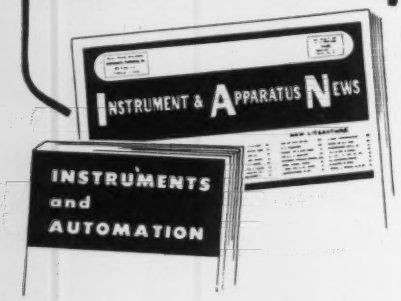

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NEW LITERATURE

SWITCHES, RELAYS

SELECTOR SWITCHES. Four-page Catalog Section 24-1 describes key or push-button selector switches for thermocouple or resistance bulb circuits.—Thermo Electric Co., Inc., Saddle Brook, N. J.

Circle 512 on inquiry card.

SWITCHES. Data sheet 129 covers Series EX1 explosion-proof switches. —Data Sheet 131 covers new 8 MA 1 adjustable mounting bracket for basic switches.—Data-Sheet 132 covers new 1SA1 impact-actuated inertia switch.—Data Sheet 134 covers new 115AT1 pull-to-unlock toggle switches.—Four-page brochure lishts some popular designs of maker's products for the machine tool and equipment industry, gives contact arrangements, ratings, actuator styles, etc.—Micro Switch, Div. of Minneapolis-Honeywell Reg. Co., Freeport, Ill.

Circle 513 on inquiry card.

TIME DELAY SWITCHES. Two-page bulletin describes three basic types, with five wiring diagrams showing principal uses.—Betts & Betts Corp., 213 West 14th St., New York 11, N. Y.

Circle 514 on inquiry card.

LOW-VOLTAGE RELAYS. Two-page service bulletin RT-100 gives full engineering specs on "Remcon" relay with built-in transformer.—Pyramid Instrument Corp., Lynbrook, L. I., N. Y.

Circle 515 on inquiry card.

CUSTOM-ENGINEERED RELAYS for electrical, electronic and industrial use are illustrated in new 16-page Catalog 157.—Magnecraft Electric Co., 3352 W. Grand Ave., Chicago 51, Ill.

Circle 516 on inquiry card.

RELAYS. Ring binder contains six 4-page bulletins on multi-contact relays, power relays, hermetic seals, actuators, etc.—Phillips Control Corp., Joliet, Ill.

Circle 517 on inquiry card.

ELECTRICAL, ELECTRONIC COMPONENTS

CERAMIC SEALS. Four-page pamphlet describes Ceramicite C-100 high-temperature ceramic material for hermetic-seal application.—Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle 518 on inquiry card.

RESISTANCE MATERIALS. Ten pieces of literature, from a 12-page technical article to catalog pages, application bulletins and specification sheets, present non-linear "Thyrite" varistors and their uses.—Magnetic Materials Section, GE, Edmore, Mich.

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COMPUTOR CAPACITORS. 4-page bulletin covers Type COM computor-quality electrolytic capacitors available in combinations ranging from 45,000 mfd at 5 volts to 850 mfd at 400 volts.—Pyramid Electric Co., North Bergen, N. J.

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NEW LITERATURE

ELECTRONIC COMPONENTS. 4-page guide offers comprehensive data on complete line of resistors and other electronic components.—International Resistance Co., 401 North Broad St., Phila. 8, Pa.

Circle 521 on inquiry card.

SILICON RECTIFIER STACKS. Six-page Bulletin ECG-2B describes characteristics and lists over 100 varieties of five types of silicon rectifier stacks with their ratings.—General Electric Co., Electronics Park, Syracuse 1, N. Y.

Circle 522 on inquiry card.

INSTRUMENT PIVOTS. Information Sheets D-19 and 1-C-110 give data on instrument pivot types applicable to the greatest number of instrument uses.—Welton V. Johnson Engrg. Co., Inc., 95 Summit Ave., Summit, N. J.

Circle 523 on inquiry card.

SERVO AMPLIFIERS. Two-page Bulletin 101 details a new line of hermetically-sealed transistorized amplifiers for servo applications.—Daystrom-Transicoil Corp., Worcester, Montgomery County, Penna.

Circle 524 on inquiry card.

DEMODULATOR, phase sensitive Model 10019, and Model 10022 Operational Meter are described in two new 4-page brochures.—Hoover Electronics Co., 3906 Liberty Heights Ave., Baltimore 7, Md.

Circle 525 on inquiry card.

EMBEDDED ELECTRONIC UNITS and Epoxy Encapsulation are described in maker's new 2-page bulletin.—Rue Products, 1628 Venice Blvd., Venice, Calif.

Circle 526 on inquiry card.

MICA WASHERS, BLANKS. Stock sizes of flat washers and disc blanks of natural mica, are listed in new Specification Bulletin 2260.—Ford Radio & Mica Corp., 536 63rd St., Brooklyn 20, N. Y.

Circle 527 on inquiry card.

MISCELLANEOUS

ABRADING AND CUTTING UNIT. 8-page Bulletin 5705 describes "Airbrasive" for deburring, abrading and cutting delicate materials.—S. S. White Industrial Div., 10 E. 40th St., New York 16, N. Y.

Circle 528 on inquiry card.

WELDING CONTROLS using Dekatron tubes in counting circuits that control welding time is described in new 12-page Bulletin SP-19.—The Taylor-Winfield Corp., Warren, Ohio.

Circle 529 on inquiry card.

TECHNICAL GLASS BLOWING is title of 4-page brochure describing products and service with emphasis on glass-metal sealing.—Glass Instruments Inc., 2285 E Foothills Blvd., Pasadena, Calif.

Circle 530 on inquiry card.

CRIMPING TOOLS. Leaflet illustrates and describes uses of two new multi-purpose crimping tools for crimping solderless terminals and connectors; stripping insulation from wires and cutting wires and insulation.—Electrix Terminals & Connectors, Inc., 990 East 67th St., Cleveland 3, Ohio.

Circle 531 on inquiry card.

CHLORINE-HANDLING 12-page Bulletin WWC3B4, summarizes physical and chemical properties of chlorine, with description of recommended practices for designing and constructing chlorine supply systems.—Fischer & Porter Co., 230 Jacksonville, Rd., Hatboro, Pa.

Circle 532 on inquiry card.

ANALYTICAL SERVICE by mass spectrometer for labs requiring such analyses too infrequently to justify purchase of instrument is described in 6-page bulletin.—Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle 533 on inquiry card.

CABINET COOLING, Four-page brochure describes six maker's rack-mounted fans for cabinet pressurizing.—McLean Engr. Labs., Princeton, N. J.

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COOLING PANEL. Four-page brochure describes Model RF (19" standard) fan-and-filter combination for pressurizing and cooling electronic equipment.—Rotron Mfg. Co., Inc., Schoonmaker Lane, Woodstock, N. Y.

Circle 535 on inquiry card.

DECIMAL EQUIVALENTS. 16 x 23" wall chart of decimal equivalents is available from:—John Hassall, Inc., Westbury, L. I.

Circle 536 on inquiry card.

STEEL SHELVING. Four-page Bulletin 2279 describes new Hallowell Electromatic steel shelving for fast assembly.—Standard Pressed Steel Co., Box 952, Jenkintown, Pa.

Circle 537 on inquiry card.

OIL BURNING MANUAL. Four-page Bulletin OB-572 discusses importance of each step in the combustion process.—Cleveland Fuel Equipment Co., 1111 Brookpark Rd., Cleveland 9, Ohio.

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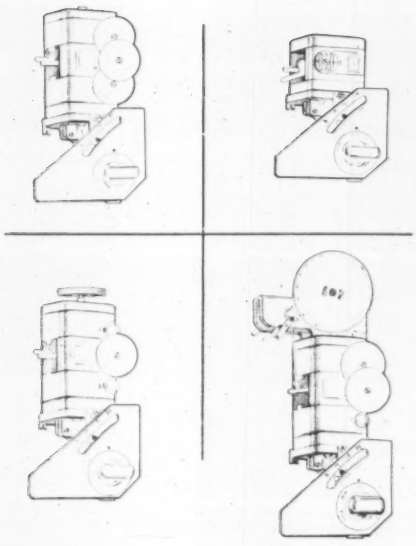

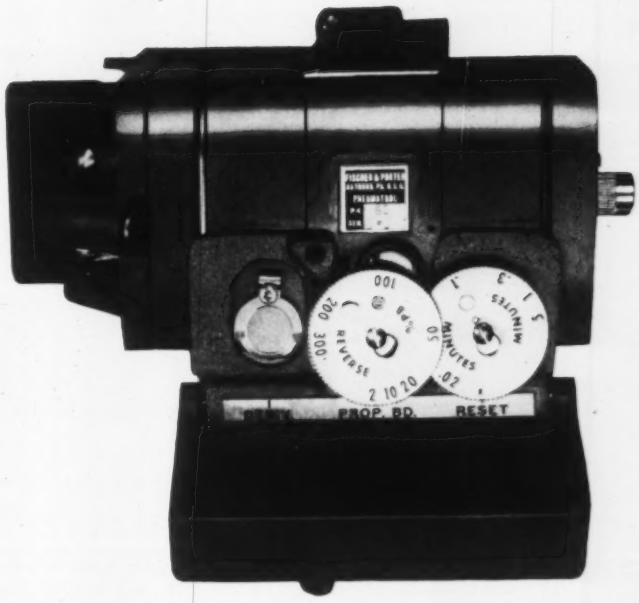

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If you'd like to investigate the renewed P-4B controller first hand, call in the Fischer & Porter field engineer serving you . . . or write for new Catalog 53P-4000 to Fischer & Porter Co., 397 County Line Road, Hatboro, Pa. In Canada, write Fischer & Porter (Canada) Ltd., 2700 Jane Street, Toronto, Ontario.

PERFORMANCE SPECIFICATIONS • SERIES 53P—P-4B CONTROLLERS

Output pressure—*3 to 15 or 3 to 18 psig*

Set point and process pressures for field or plug-in models—*3 to 15 psig*

Index tracking at any output pressure—*within 1% of scale (Reset controller)*

Temperature limit—*225 F*

Supply pressure—*17 to 22 psig*

Zero frequency gain (Reset controller)—*approximately 300*

Derivative gain—*approximately 12*

Field mounting manifold cut-off valve—*air to open*

Steady state air consumption—*0.08 scfm*

	In Case Controllers	Plug-In And Field Mounted
On-off	53PR 4101	
"Universal" controller: 2-50% proportional, on-off, and 2-100% differential gap	53PR 4241	53PN 4240
Proportional only	53PR 4301	53PN 4300
Proportional plus fast derivative	53PR 4411	53PN 4410
Proportional plus slow derivative	53PR 4421	53PN 4420
Proportional plus fast reset	53PR 4511	53PN 4510
Proportional plus slow reset	53PR 4521	53PN 4520
Proportional plus fast derivative plus fast reset	53PR 4611	53PN 4610
Proportional plus fast derivative plus slow reset	53PR 4631	53PN 4630
Proportional plus slow derivative plus slow reset	53PR 4621	53PN 4620
Ratio—Proportional plus fast reset	53PP 4511	

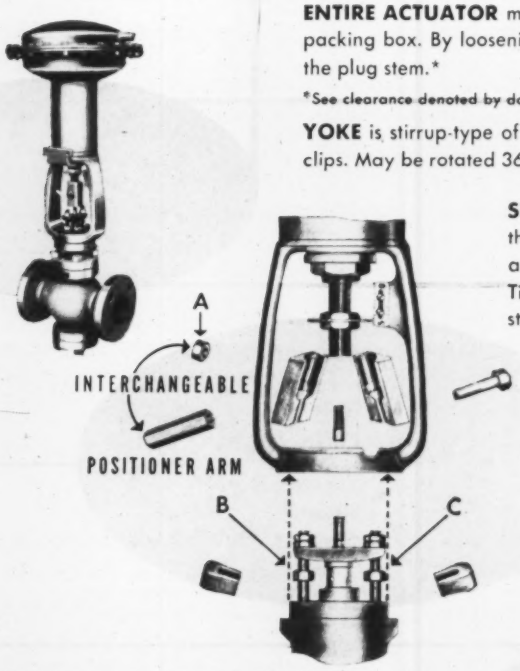
FISCHER & PORTER CO.
Complete Process Instrumentation

For more information circle **169** on inquiry card.

Simplicity...

KEYNOTE

OF THE NEW H-D ACTUATOR



ENTIRE ACTUATOR may be removed and replaced without disturbing the packing box. By loosening nuts A, B, and C the actuator may be lifted over the plug stem.*

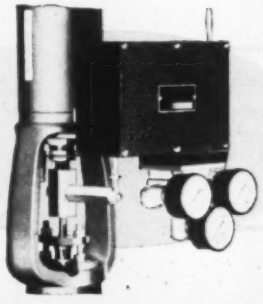
*See clearance denoted by dotted lines and arrows.

YOKE is stirrup-type of cast nodular iron. Held to bonnet by **stainless steel** clips. May be rotated 360° on bonnet.

SPLIT COUPLING has L.H. (upper) and R.H. (lower) threads. Stems do not engage—do not meet. Coupling acts as a turnbuckle for adjusting plug seating tension. Tightly clamped coupling prevents twisting of plug stem.

SLOTTED HOLDING CLIPS permit removal of clips without removing nuts B and C.

SPRINGS are available in three interchangeable ranges, 3-15, 5-25, and 6-30 psi. Interchangeable in any actuator — no additional parts required.



POSITIONER BRACKET (Universal) supplied on all valves for the mounting of any positioner. No valve disassembly required — Positioner can be mounted in the field by removing nut A and replacing it with the positioner arm.

HAMMEL-DAHL COMPANY

WARWICK INDUSTRIAL PARK, PROVIDENCE 5, R. I., U. S. A.

SALES OFFICES IN ALL PRINCIPAL CITIES

MANUFACTURERS ABROAD: GUELPH ENGINEERING CO., LTD., GUELPH, ONT., CANADA

J. BLAKEBOROUGH AND SONS, LTD., BRIGHOUSE, YORKS, ENGLAND; TERMOKIMIK CORP., MILAN, ITALY

For more information circle **170** on inquiry card.